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DEFENSE PROCUREMENT OUTCOMES IN THE INCENTIVE CONTRACT ENVIRONMENT

by

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DISCLAIMER

The views expressed herein are those of the author and do not necessarily reflect the views of the Air University, the United States Air Force, or the Department of Defense.

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TABLE OF CONTENTS

		Page
ACKNOWLEDGMENTS		iv
LIST OF TABLES		viii
LIST OF ILLUSTRATIONS		xi
Chapter		
I	INTRODUCTION	1
	Resource Allocation	1
	The Incentive Environment	4
	Early Examples	8
	Shift in Contract Use	9
	Perspectives	11
	Previous Contract Outcome Research	13
	Questions to be Answered	14
	Organization	16
II	THE INCENTIVE CONTRACT STRUCTURE	18
	Need for a Variety of Contract Types	18
	Firm-Fixed-Price Contracts	19
	Cost-Plus-A-Fixed Fee Contracts	19
	Incentive Contracts	21
	Multiple Incentives	26
	An Example	28
	Cost-Plus-Award-Fee Contracts	28
	Selection of the Correct Contract Type	31
	Concluding Remarks	31
III	PROFITS, OBJECTIVES, AND LIMITS	32
	Economists Views on the Role of Profit	33
	Profits and Goals of the Firm	35
	Profit Limits: The Contractor's View	37
	Profit Limits: The Customer's View	41
	Concluding Remarks	43

IV INCENTIVE ENVIRONMENT OUTCOMES--A MACROSCOPIC ANALYSIS 45

Concentration of Defense and Space Market 45
The Fortune 500 49
The Fortune 500 Divided 50
Profit and Return 53
Return on Sales, Assets, and Net Worth 55
Capital Turnover 63
Sales Dollars Per Employee 67
Conclusions 67

V CONTRACT OUTCOMES--PART I 71

Data Source and Definitions 71
Sample Description 72
Contract Growth Defined 75
Change and Overrun/Underrun for Three Types of Contracts 75
Change and Overrun/Underrun for Two Types of Work 76
Relationship of Contract Change and Overrun/Underrun 78
Analysis of Variance of Contract Change 79
Analysis of Variance of Contract Overrun/Underrun 80
Change and Overrun/Underrun for Incentive Contracts 82
Regression of Sharing Rates, Overrun/Underrun, and Change 87
Multiple Incentive Contract Outcomes 91
Comparison of Results with Other Research 93
Conclusions 95

VI CONTRACT OUTCOMES--PART II 98

Profit Definitions 98
Going In and Coming Out Profits for Three Types of Contracts 99
Analysis of Variance of Going In and Coming Out Profits 103
Profits for Incentive Contracts 106
Regression of Profits, Sharing Rates, and Contract Growth 109
Historical Profit Information 111
Conclusions 114

VII THE QUANTITATIVE RESULTS AND OTHER OBSERVATIONS 116

Relationship of Industry Trends and Contract Outcomes 116
Factors Identified in Previous Research 117
Intercontract Dependencies 119
Incentive Dilution 121
Tax Effect 123
Matching of Contract Type and Uncertainty 123
A Caveat 125

VIII SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS 127

Summary 127
Conclusions 130
Recommendations 132
Finis 134

BIBLIOGRAPHY 135

LIST OF TABLES

Table		Page
1-1	Cost Plus Fixed Fee Contracts as a Percentage of Total Contract Awards	7
1-2	Awards by Type of Contract Pricing Provision as a Percentage of Total Contract Dollars (FY 1959-1968)	10
1-3	Awards by Type of Contract Pricing Provision as a Percentage of Total Number of Awards (FY 1959-1968)	12
2-1	Examples of Performance Incentives on Recent Major Programs	27
2-2	Cost, Schedule, and Performance Incentives in an Air Force Space Contract	29
3-1	Net Return on Renegotiable Sales--1968	39
4-1	Percentage of DOD Procurement Dollars Awarded to Contractors Ranked by Dollar Share (FY 1959-1968)	47
4-2	Military Prime Contract Awards by Size (FY 1967)	48
4-3	Number of Companies in Groups O, L, and H (1956-1967)	52
4-4	Annual Average DOD and NASA Sales as a Percentage of Total Sales for Groups L and H (1956-1967)	52
4-5	Annual Average Net Profit for Groups O, L, and H (1956-1967)	55
5-1	Contract Sample by Year of Award and Year of Completion	73
5-2	Contract Sample by Type of Contract, Work, and Service	74
5-3	Contract Sample by Initial, Adjusted, and Final Price	74
5-4	Average Contract Change and Overrun by Type of Contract	76
5-5	Average Contract Change and Overrun by Type of Work	78

5-6 Regression Coefficients for Six Tests with Overrun/Underrun Percentage as the Dependent Variable and Change Percentage as the Independent Variable 79

5-7 Analysis of Variance of Contract Change for 834 FPI, CPIF, and CPFF Contracts 81

5-8 Analysis of Variance of Contract Overrun/Underrun for 834 FPI, CPIF, and CPFF Contracts 83

5-9 Average and Standard Deviation of Sharing Percentage for Each of Three Groups of Incentive Contracts . . . 84

5-10 Average Change and Overrun/Underrun for Each of Three Groups of Incentive Contracts 85

5-11 Analysis of Variance of Contract Change for 264 Incentive Contracts 86

5-12 Analysis of Variance of Overrun/Underrun for 264 Incentive Contracts 88

5-13 Regression Coefficients for Eight Tests with Overrun/Underrun Percentage as the Dependent Variable and Contractor's Share Ratio as the Independent Variable 90

5-14 Regression Coefficients for Eight Tests with Change Percentage as the Dependent Variable and Contractor's Share Ratio as the Independent Variable 91

5-15 Outcomes of Contracts Having Cost and Performance Incentives 92

5-16 Change and Overrun for FPI, CPIF, and CPFF Contracts as Found by Fisher, Jones, and Belden 94

6-1 Initial, Adjusted, and Final Profit Percentages for 834 FPI, CPIF, and CPFF Contracts 99

6-2 Analysis of Variance of Going In Profit as a Percentage of Initial Cost for 834 FPI, CPIF, and CPFF Contracts 104

6-3 Analysis of Variance of Coming Out Profit as a Percentage of Actual Cost for 834 FPI, CPIF, and CPFF Contracts 105

6-4 Analysis of Variance of Going In Profit as a Percentage of Initial Cost for 264 Incentive Contracts 107

6-5 Analysis of Variance of Coming Out Profit as a Percentage of Actual Cost for 264 Incentive Contracts 108

6-6 Regression Coefficients for Eight Tests with Going In Profit and Contractor's Share Ratio as the Independent Variables and Change Percentage as the Dependent Variable 110

6-7 Regression Coefficients for Eight Tests with Adjusted Going In Profit and Contractor's Share Ratio as the Independent Variables and Overrun/Underrun Percentage as the Dependent Variable 112

6-8 Going In, Adjusted, and Coming Out Profits for DOD Contracts: 1959-1968 113

LIST OF ILLUSTRATIONS

Figure		Page
2-1	Fixed Price Contract: Cost - Profit Curve	20
2-2	Fixed Fee Contract: Cost - Profit Curve	22
2-3	Cost Plus Incentive Fee Contract: Cost - Profit Curve . .	23
2-4	Fixed Price Incentive Contract: Cost - Profit Curve . . .	25
4-1	Net Profit Trends for Groups O and H	54
4-2	Annual Average Return on Sales for Groups O, L, H, and the SEC/FTC Durable Goods Firms	57
4-3	Annual Average Return on Assets for Groups O, L, H, and the SEC/FTC Durable Goods Firms	60
4-4	Annual Average Return on Net Worth for Groups O, L, H, and the SEC/FTC Durable Goods Firms	62
4-5	Annual Average Total Capital Turnover for Groups O, L, and H	65
4-6	Annual Average Equity Capital Turnover for Groups O, L, and H	66
4-7	Annual Average Sales Dollars Per Employee for Groups O, L, and H	68
5-1	Distribution of Overruns for FPI, CPIF, and CPFF Contracts	77
6-1	Distribution of Going In Profits by Type of Contract . .	101
6-2	Distribution of Coming Out Profits by Type of Contract .	102

CHAPTER I

INTRODUCTION

> Every dollar we spend inefficiently or ineffectively is not only an unnecessary addition to the arms race which threatens all mankind, but an unfair burden on the taxpayer, or an unwise diversion of resources which could be invested somewhere to serve our national interests at home or abroad, or a dollar that could, even if kept in the military budget, be invested in something that would better strengthen our military posture. -- Robert S. McNamara (19:21)[1]

The world's largest consumer, the United States government, has significantly altered its method for procuring a major portion of its required goods and services. The primary purpose of the research for this dissertation is to examine the results of this change. Specifically this change involved an attempt to motivate the producers to more efficient performance and the vehicle of this change was the use of contracts containing provisions for automatic cost and profit sharing. The Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA) designed and implemented this procurement policy alteration.

Resource Allocation

This policy shift was a part of the overall change in the management of the DOD, forced by the leadership of former Secretary of Defense Robert S. McNamara. How automatic cost and profit sharing relates to the overall resource allocation management function is a logical beginning.

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[1] The first number refers to the bibliography listing; the second refers to the specific page.

The DOD consumes half of the total Federal budget. Of the DOD budget, approximately forty percent is for the research, development, and procurement of the aircraft, missiles, ships, and other military hardware deemed necessary to support the defense mission. The billions of dollars involved virtually defy being placed in a market economy context.

How these billions of dollars should be spent most effectively to obtain a balanced force structure to meet the defense mission is a problem of tremendous complexity. To say that decisions such as the proper mix of manned bombers and missiles to have in the operational inventory at any particular time are difficult would be an understatement. However, given a relatively fixed budget, a more complex problem is to allocate resources meaningfully between, say, strategic offensive and airlift forces. The latter problem involves comparing, without the assistance of an obvious common measure of value or return, alternatives which are not direct substitutes for each other.

The management tool now used by DOD in the resource allocation decision process is the Planning, Programming, and Budgeting System (PPBS). Though it was first introduced in 1954 by David Novick's RAND publication, Efficiency and Economy in Government Through New Budgeting and Accounting Procedures (11:83), actual implementation of PPBS was not accomplished until after the 1961 appointments of McNamara as Secretary and Charles J. Hitch as Assistant Secretary of Defense (Comptroller). That little happened as an immediate result of Novick's work is evidenced by the revelations of General Maxwell Taylor in The Uncertain Trumpet. (18) The pre-McNamara approach to resource allocation is succinctly stated in the Harvard Business Review by Martin Meyerson:

> Prior to 1961 and Secretary McNamara, military budget planning was based essentially on two guidelines. The first guideline was a basic National Security Policy document which attempted to define U.S. foreign policy. The second guideline was a budget ceiling set by the President for military expenditures allocated as a relatively fixed percentage of the gross national product. . . . With these guidelines, the service chiefs of staff were asked to split up the budget. As General Maxwell Taylor indicated: 'We put a sack worth about $40 billion in front of four very earnest men and asked them to split it up.' (109:112)

The PPBS demands a comparison of alternatives (elements) within one of the nine programs. Here "program" refers to a broad military mission or activity. The nine programs are:

1. Strategic Retaliatory Forces
2. Continental Air and Missile Defense Forces
3. General Purpose Forces
4. Airlift/Sealift Forces
5. Reserve and Guard Forces
6. Research and Development
7. General Support
8. Retired Pay
9. Military Assistance

Unfortunately, costs of alternatives are only estimates at the time the alternatives are being compared. In fact they may be very rough estimates. Peck and Scherer found that in the twelve weapon systems they analyzed, the average development cost prediction error, as a percentage of initial target cost, was 220%, with a standard deviation of 170%. (12:16-45) With uncertainty of this magnitude, deterministic marginal utility theory and deterministic cost benefit analysis in comparing alternatives are meaningless.

It is argued that contractors and even certain government organizations had little or no motivation to properly estimate weapon systems' costs at an early stage or to control the costs after signing the contracts. McNamara stated, "I believe American business needs higher incentives . . ." (104:7) He reasoned that:

> A contractor's motivation for good management and tight cost control usually varies in direct proportion to the degree of risk he bears. CPFF contracts, being virtually risk-free, provide no such motivation. In contrast, fixed price or incentive contracts offer strong inducements for managerial efficiency because they impose serious financial penalties on the contractor who exceeds his cost estimates, defaults on his delivery schedule, or who fails to meet the performance specifications. (45:191)

The Incentive Environment

The current incentive environment did not just happen. It was finely planned and charted by Defense Department policy makers. In setting the stage for this environment the DOD took three specific management actions. The administrative ceiling on profits for certain types of contracts (the predominately used contract types are discussed in Chapter II) was eliminated, ASPR was rewritten to emphasize preference for fixed-price and incentive contracts, and the Cost Reduction Program was formulated including an emphasis on fixed-price and incentive contracts as a salient element. Because of the timing of these actions the beginning of the incentive environment, as used in this research is defined as July 1, 1962, the beginning of fiscal year 1963.

The statutory limitations on profits, as a percentage of target cost, are 15% for experimental, development, and research undertakings and, with few exceptions, 10% for other types of work. These limitations apply to cost-type contracts. Upon taking office, McNamara found that DOD,

through ASPR, had imposed lower administrative limits of 10% for experimental, development, and research work and 7% for other types of work. Since maintaining low upper limits on profit is inconsistent with offering incentives to industry, McNamara had the administrative limits removed.

Revision 8 of the 1960 ASPR was published on March 15, 1962. It was a substantial revision in that the contractor's cost responsibility was emphasized and preferences for certain types of contracts were stated. As the preferred contract type, firm fixed-price was singled out while strict limits were imposed on the use of fixed-fee contracts. In introducing the preferred contract types, ASPR 3-402 states that:

> The firm fixed-price contract is the most preferred type because the contractor accepts full cost responsibility, and the relationship between cost control and profit dollars is established at the outset of the contract. Accordingly, whenever a reasonable basis for firm pricing exists the firm fixed-price contract shall be used . . . Similarly, a profit incentive to control costs can be achieved through use of the fixed-price incentive contract, and to a lesser degree, the cost-plus-incentive-fee contract, where appropriate target costs and incentive arrangements can be negotiated. (36)

During fiscal year 1962, McNamara's now famous Cost Reduction Program was being developed for full implementation at the beginning of fiscal year 1963. In his July 5, 1962, Memorandum to the President, McNamara outlined the program and its goals. The program's areas of emphasis are: (35:476)

1. Buying Only What We Need
    a. Refining Requirement Calculations
    b. Increased Use of Excess Inventory
    c. Eliminating 'Goldplating'
    d. Inventory Item Reduction
2. Buying at the Lowest Sound Price
    a. Shift from Non-Competitive to Competitive Procurement
    b. Shift from CPFF to Fixed or Incentive Price

c. Direct Purchase Breakout
d. Multi-year Procurement

3. Reduce Operating Costs

a. Terminating Unnecessary Operations
b. Consolidation and Standardization
c. Increasing Efficiency of Operations

Though the three general headings are reasonable, germane, and non-controversial, the subheadings are not all without controversy. An example of the DOD/Congressional disagreement is included in a following portion of this section.

The "Shift from CPFF to Fixed or Incentive Price" Contract, item 2b, was truly a motivating force in establishing the incentive environment. McNamara established annual goals for each item in the program. When asked about the importance of meeting the goals McNamara emphatically responded:

> This program is detailed. It has been laid out Military Department by Military Department, item by item. Each of the Secretaries has accepted his share of it. I carry around in my pocket the details of it which I discuss with them periodically. I check to make damn sure we are on the targets. (7:195)

That this emphasis elicited the planned response is shown in Table 1-1. The rapid decrease of CPFF contracts as a percent of total contract awards from over 30% to the 10% level was swift. The slight annual increase since 1965 may be attributed to an early over-response or Viet Nam buying.

Not only were goals established but the outcomes were converted to a dollar value. The savings attributed to this element of the program are ". . . ten cents on every dollar switched from 'cost plus fixed fee' contracts." (117:5) This ten cent multiplier has no known specific basis in fact It has been discussed and argued from industry to the Congress.

TABLE 1-1

COST PLUS FIXED FEE CONTRACTS
AS A PERCENTAGE OF TOTAL CONTRACT AWARDS[a]

Fiscal Year	Goal	Actual
1962	-	32.5%
1963	25.8%	20.7
1964	19.1	12.0
1965	12.3	9.4
1966	9.8	9.9
1967	9.8	10.4
1968	9.8	10.8

[a] Source: (35:191), (38)

The following dialogue, quoted by Clark Mollenhoff from a House of Representatives investigation of the Cost Reduction Program, demonstrates the disagreement on the validity of the 10%: (10:403)

> "The point here is that if this contract had been cost plus fixed fee our belief is that it would have been ten percent higher than it actually is today." -- DOD Official.
>
> "You can't prove it," -- U. S. Representative.
>
> "You can't prove it either way." -- DOD Official.

That McNamara believed strongly in this section of the Cost Reduction Program is evidenced in his submission of the 1968 Defense Department budget.

> In total, the shift from CPFF to more effective contractual arrangements has enabled the Defense Department to save $1.1 billion over the 5 year period, i.e., ten cents on each dollar shifted. A valuable by-product of this shift . . . has been the reduction of large numbers of detailed reports and controls which are required for CPFF contracting. Although this, too, produces real savings, they are not reflected in the published results of the Cost Reduction Program. (46:192)

Early Examples

Incentive contracts certainly aren't a product of the 1960's. They have been used in the procurement of American war goods for over 100 years. The literature frequently mentions specific contracts from such historical milestones as the Civil War, Wright Brothers, and World War I.

When, in 1862, the Monitor fought the Merrimac, the Monitor's contractor had $275,000 riding on the outcome. This was so because the contract called for the government to pay the contractor only if the Monitor floated, attained a specified minimum speed, and won its first battle. Although the battle was fought to a draw the first conditions were met and the contractor was paid. (132:4) Assistant Secretary of Defense Paul R. Ignatius claims that, "The best contract we ever wrote was in the Civil War. The Monitor developer wasn't paid unless he defeated the Merrimac in battle. We've been working back in the direction." (99:102)

On December 23, 1907 the Army Signal Corps advertised its specificiation for one "heavier-than-air flying machine." It required that "the flying machine should be designed to have a speed of at least forty miles per hour in still air, but bidders must submit quotations in their proposals for cost depending upon the speed attained during the trial flight, according to the following scale:

40 miles per hour, 100 percent
39 miles per hour, 90 percent
38 miles per hour, 70 percent
37 miles per hour, 70 percent
36 miles per hour, 60 percent
Less than 36 miles per hour rejected

41 miles per hour, 110 percent
42 miles per hour, 120 percent
43 miles per hour, 130 percent
44 miles per hour, 140 percent"

Wilbur and Orville Wright signed a contract with a $25,000 target price for this flying machine on February 10, 1908. That contract yielded a reward/penalty potential of $2,500 for each one mile per hour over or under the target of forty. "The Aircraft whizzed along at over 42 miles per hour and the Wright Brothers collected a bonus of $5,000 in addition to the contract price of $25,000." (30:1)

One of the early cost-incentive contracts was written during World War I. Note that the incentives used for the Monitor and with the Wright Brothers were based upon actual performance of the hardware. In a World War I shipbuilding contract a substantial automatic incentive was included for cost underruns. The contract provided a 50/50 cost sharing for cost outcomes less than target with no sharing for cost overruns. (48:3)

Shift in Contract Use

The incentive environment, as was previously shown, forced a substantive decrease in the use of CPFF contracts. Table 1-2 illustrates this decrease and the corresponding increase in use of incentive and fixed price contracts. This table excludes intragovernmental purchases and actions of less than $10,000. These two categories amount to approximately 10% of the total military procurement dollars. For example, of the $43.8 billion awarded in fiscal year 1968, $1.0 billion was for intragovernmental transactions and $3.7 billion was for actions of less than $10,000. (38:48)

In fiscal year 1961, the year [illegible]ch McNamara became Secretary, cost reimbursement contracts represented 42.1% of the $22.9 billion of

TABLE 1-2

AWARDS BY TYPE OF CONTRACT PRICING PROVISION

AS A PERCENTAGE OF TOTAL CONTRACT DOLLARS (FY 1959-1968)[a]

Type of Pricing Provision[b]	Fiscal Year									
	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
Fixed Price Type (Sub-Total)	59.1%	57.4%	57.9%	60.8%	64.9%	71.2%	76.5%	79.2%	78.9%	77.6%
Firm	32.8	31.4	31.5	38.0	41.5	46.3	52.8	57.5	56.3	52.7
Incentive	15.3	13.6	11.2	12.0	15.8	18.5	16.6	15.9	17.8	18.7
Other[c]	11.0	12.4	15.2	10.8	7.6	6.4	7.1	5.8	4.8	6.2
Cost Reimbursement Type (Sub-Total)	40.9	42.6	42.1	39.2	35.1	28.8	23.5	20.8	21.1	22.4
Incentive	3.2	3.2	3.2	4.1	11.7	14.1	11.2	8.3	8.3	9.0
Fixed Fee	34.2	36.8	36.6	32.5	20.7	12.0	9.4	9.9	10.4	10.8
Other[d]	3.4	2.6	2.3	2.6	2.7	2.7	2.9	2.6	2.4	2.6
Total Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total Dollars (In Billions)	$22.9	$21.2	$22.9	$25.8	$26.2	$25.3	$24.3	$33.5	$39.2	$39.1

[a] Source: Military Prime Contract Awards, various issues. (38)

[b] Represents procurement actions of $10,000 or more excluding Introgovernmental.

[c] Includes Redeterminable and Escalation.

[d] Includes No Fee and Time and Materials.

contract awards of $10,000 or more. Of the cost reimbursement contracts, 7.6 was of the incentive fee type. By fiscal year 1968, cost reimbursement contracts represented only 22.4% of the $39.1 billion of contract awards. Incentive fee contracts had increased to 40% of the cost reimbursement category. For the same period fixed price type increased from 57.9% to 77.6% of the contract award dollar. The fixed price and fixed price incentive by fiscal year 1968 represented 92% of the fixed price category.

The shift in contract types is extremely convincing when viewed in terms of contract dollars but in terms of numbers of contracts the shift is far less dramatic. This is shown in Table 1-3. In fiscal year 1961 cost reimbursement contracts represented 16.8% of the 122 thousand procurement actions of $10,000 or more. By fiscal year 1968 this figure had dropped to 10.2%. The firm fixed price share of the number of contracts increased from 73.3% to 82.3% while the fixed price incentive share slightly decreased from 4.3% to 3.9%.

Perspectives

This research examines the impact of the incentive environment from two different perspectives. The specific questions investigated are listed in a subsequent section of this chapter. First, the impact is analyzed in a macroscopic sense, i.e., what has happened to the defense and space contractors? Have they become more profitable? Second, a microscopic viewpoint is assumed by analyzing the outcomes of a large sample of incentive and fixed fee contracts.

The macroscopic analysis is based upon those firms appearing on the annual Fortune list of the largest 500 manufacturing firms during the

TABLE 1-3

AWARDS BY TYPE OF CONTRACT PRICING PROVISION

AS A PERCENTAGE OF TOTAL NUMBER OF AWARDS (FY 1959-1968)[a]

Type of Pricing Provision[b]	Fiscal Year									
	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
Fixed Price Type (Sub-Total)	84.6%	82.8%	83.2%	84.0%	84.2%	85.7%	87.5%	90.4%	91.0%	89.8%
Firm	72.4	71.8	73.3	74.7	76.1	76.4	79.7	83.0	83.8	82.3
Incentive	5.4	4.7	4.3	3.4	3.1	4.6	4.2	3.6	3.7	3.9
Other[c]	6.8	6.3	5.6	5.9	5.0	4.7	3.6	3.8	3.5	3.6
Cost Reimbursement Type (Sub-Total)	15.4	17.2	16.8	16.0	15.8	14.3	12.5	9.6	9.0	10.2
Incentive	0.5	0.6	0.7	0.9	1.7	2.3	2.4	1.8	1.5	1.8
Fixed Fee	10.2	12.1	12.1	11.4	10.4	8.1	6.3	4.6	4.5	5.1
Other[d]	4.7	4.5	4.0	3.7	3.7	3.9	3.8	3.2	3.0	3.3
Total Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total Awards (In Thousands)	120.7	118.0	122.3	141.5	149.7	146.2	156.8	206.1	229.4	208.0

[a] Source: Military Prime Contract Awards, various issues. (38)

[b] Represents procurement actions of $10,000 or more excluding Intragovernmental.

[c] Includes Redeterminable and Escalation.

[d] Includes No Fee and Time and Materials.

1956-1957 period. The firms are not divided into the traditional industrial classifications such as automotive, electronics, or aircraft. Rather, they are grouped on the basis of the percentage of their total sales represented by their combined DOD and NASA sales. Various financial ratios are calculated and examined for each group. These include return on sales, return on assets, return on net worth, and capital turnover. The ratios are compared between groups and also with the Securities Exchange Commission/Federal Trade Commission statistics for durable goods manufacturers.

Actual contract outcomes are examined for a total of 834 contracts awarded and completed during the 1963-1968 period. For this period this sample represents almost all Army, Navy, and Air Force incentive and fixed fee contracts for which the Report of Contract Completion (DOD Form 1500) had been filed with DOD prior to the end of fiscal year 1968.

Previous Contract Outcome Research

Continued interest in government contracting is demonstrated by the great number of previously completed studies, primarily government sponsored. Many of these studies have been focused on actual contract outcomes although they have typically examined one or at most a small subset, of the measurable contract variables. One of the primary difficulties encountered by previous analysts has been obtaining sufficient and current data. Unfortunately, only recently has the Defense Department maintained the detailed data set which is necessary for a thorough contract outcome analysis. Even now it is not possible to include the outcomes of firm fixed price contracts since the actual profit earned on each contract is known only to the contractor.

In the literature search phase, seven studies were identified as those providing a logical framework upon which to base this research. Also, these studies have provided ideas for data analysis and presentation. In chronolcgical order they are:

1. Moore, Frederick T. Military Procurement and Contracting: An Economic Analysis. June, 1962. (79)

2. Scherer, Frederic '. The Weapons Acquisition Process: Economic Incentives. 1964. (14)

3. Deavers, K. L. and McCall, J. J. Notes on Incentive Contracting. September, 1966. (63)

4. Jones, Troy H. A Study of Selected Aspects of the Use of Incentive Contracts in U. S. Air Force Procurement Management. 1967. (144)

5. Logistics Management Institute, Defense Industry Profit Review. November, 1967. (75)

6. Logistics Management Institute, An Examination of the Foundations of Incentive Contracting, May, 1968. (76)

7. Fisher, Irving N. A Reappraisal of Incentive Contracting Experience. July, 1968. (68)

Questions to be Answered

Has the defense and space industry experienced a relative change in profit due to the incentive environment? Is there a noticeable difference in profit outcomes because of automatic incentives? Have automatic incentives caused a noticeable difference in contract growth--change in target cost and overrun/underrun outcomes? These three broad questions provide the foundation for this research. Upon them are based

a set of specific questions, grouped into five areas of emphasis: industry profitability trends, contract growth outcomes, contract profit outcomes, and extra-contractual costs and benefits. It is hoped that the answers will jointly provide an indication of the results of the incentive emphasis and contribute to the foundation upon which future DOD and NASA contract pricing policy is determined.

Incentive Profitability Trends

1. What have been the profitability trends, measured as return on sales, assets, and net worth, of the defense and space segment of industry compared to firms oriented to non-government customers?

Contract Growth Outcomes

2. Is there a significant relationship between authorized contract changes and overruns/underruns?

3. What is the relationship of contract growth and contract type--FPI, CPIF, and CPFF?

4. What is the relationship of contract growth and the size of the automatic incentive sharing ratio?

5. What is the relationship of contract growth and the type of work--production and research and development?

Contract Profit Outcomes

6. Is there a difference in average profit among the different types of contracts?

7. What is the relationship of average profit and the various automatic incentive sharing ratios?

8. Is there a difference in average profit between contracts for production and contracts for research and development?

Incentive Combination Outcomes

9. What is the relationship between incentive outcomes on multiple incentive contracts?

Extra-Contractual Costs and Benefits

10. Have there been extra-contractual costs and benefits resulting from the incentive environment?

Organization

This introductory chapter defined the incentive contracting environment, highlighted some historical examples, revealed the shift in usage of various contract types, discussed the two perspectives of the empirical analysis, and specified the questions to be answered by the research.

Chapter II sets forth the need for a variety of contract types, discusses the structural differences between firm-fixed-price, fixed-price-incentive, cost-plus-incentive-fee, and cost-plus-a-fixed-fee contracts, and provides some current examples of incentive contracts.

Profit is the subject of Chapter III. Included are various viewpoints on the profit motive and other goals of the firm. Also, the concept of explicit and implicit upper and lower profit limits is considered. These limits are discussed from the customer and the contractor points of view.

Chapter IV examines the profitability trends for firms grouped on the basis of the percentage of their total sales represented by government business. These groups are also compared with a composite group of all U.S. durable goods manufacturers. In addition, various financial indicators such as sales, assets, and net worth are examined.

Chapters V and VI provide an analysis of the growth and profit outcomes of a large sample of DOD contracts. This empirical analysis is based heavily upon analysis of variance and regression procedures. It includes a grouping of contracts by type of pricing, type of work, and size of the sharing ratio.

The relationship of the macroscopic perspective of Chapter IV and the empirical view of Chapters V and VI is discussed in Chapter VII. This chapter reviews previous research on the extra-contractual costs and benefits of the incentive contracting environment and discusses additional factors.

Conclusions, recommendations and a summary are included in Chapter VIII.

CHAPTER II

THE INCENTIVE CONTRACT STRUCTURE

What is an incentive contract? How does it differ from other types of contracts? It is not the purpose of this section to provide a detailed discussion of the many types of contracts authorized by the Armed Services Procurement Regulation (ASPR). (The interested reader may wish to refer to ASPR Section 3, Part 4 for complete information about all types of contracts authorized by DOD.) The purpose here, is to provide a general conceptual understanding of the primary structural differences between cost-plus-a-fixed-fee (CPFF), cost-plus-incentive-fee (CPIF), fixed-price-incentive-fee (FPI), and firm-fixed-price (FFP) contracts. Cost-plus-award-fee (CPAF) contracts are also introduced.

Need for a Variety of Contract Types

The very nature of the goods and services procured by DOD and NASA necessitates a variety of contract types. These government agencies consume large quantites of such items as paper, pencils, gasoline, and automobiles; however, only 25% of the Federal government purchasing dollar is spent for civilian-type commodities. (8:553) Obviously, complex defense and space systems are not available as "off-the-shelf" items with established price schedules. Each system is researched, designed, and produced in a multiyear cycle which averages "about eight years . . . to complete system development." (106:113) Examples of these systems are such technologically demanding procurements as the Air Force's

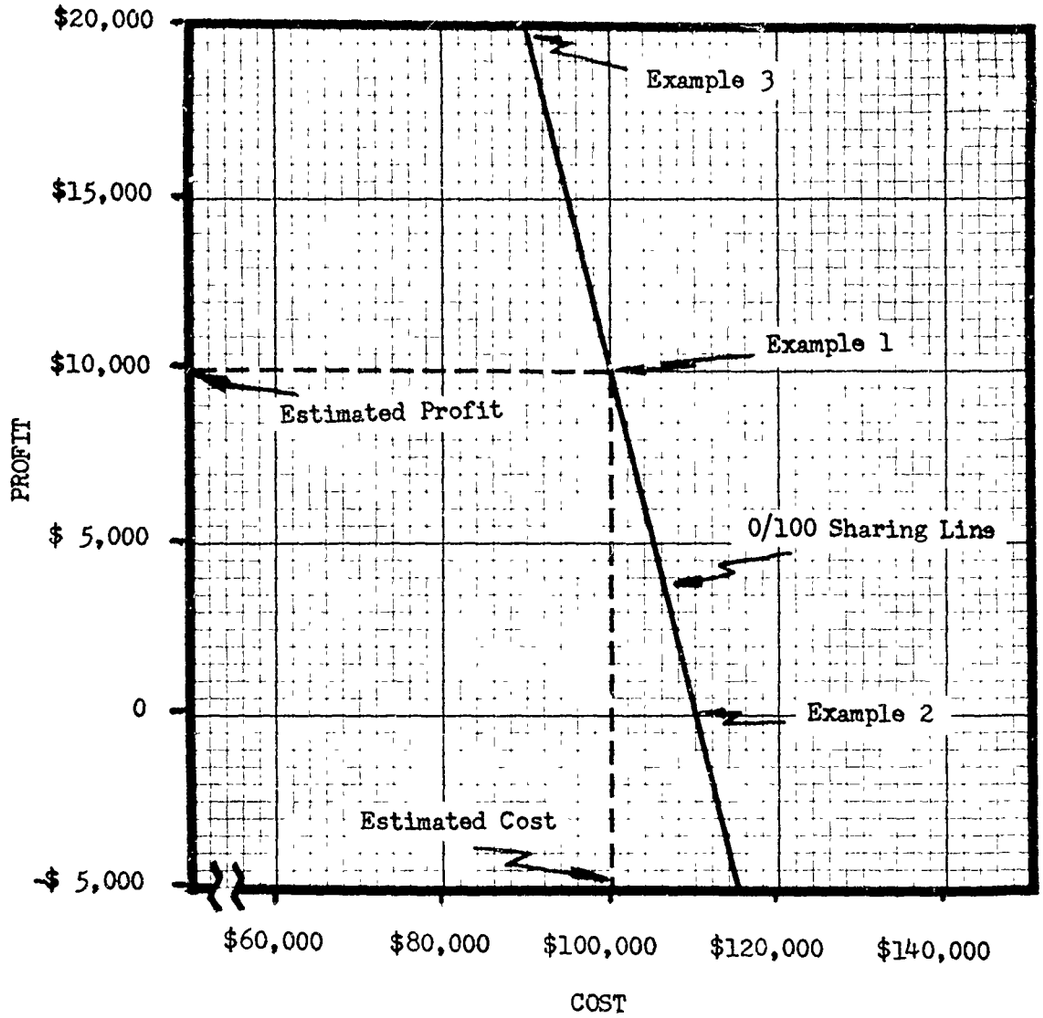
Manned Orbiting Laboratory, the Navy's Deep Submergence Rescue Vehicle, and NASA's Appollo space capsule. For procurements of this type the risk involved is often partially shared by the customer through certain contract provisions. This is because cost estimating is extremely difficult and plagued with uncertainty.

Firm-Fixed-Price Contracts

The FFP contract is conceptually simple. The customer and the contractor agree on a price, and that price is the amount paid upon completion of the contract. The contractor's profit is primarily determined by his management actions. Figure 2-1 shows graphically how profit and cost are related in a FFP contract having a price of $110,000. Any point on the solid line represents a cost and profit which algebraically sum to equal the contract price. It is called a 0/100 share line since the contractor is fully responsible for cost overruns or underruns. Note that the FFP contract provides the potential for cost outcomes which yield a loss. Included below the graph are three specific examples which demonstrate profit variation as a function of actual cost. For instance, Example 3 includes an accrued cost of $90,000 which yields a profit of $20,000 for this contract having a fixed-price of $110,000. This type of contract should provide the greatest motivation to the contractor because from it he reaps the full benefit of all cost reduction accomplishments. Although it is the contract type having the maximum incentive, the term "incentive contract" is usually reserved for those contracts incorporating specific automatic cost sharing arrangements.

Cost-Plus-A-Fixed-Fee Contracts

On the other end of the risk spectrum from a FFP contract is the



Examples:	1	2	3
Contract Price	$110,000	$110,000	$110,000
Actual Cost	100,000	110,000	90,000
Actual Profit	10,000	0	20,000
Actual Profit %	10.00%	0.00%	22.22%

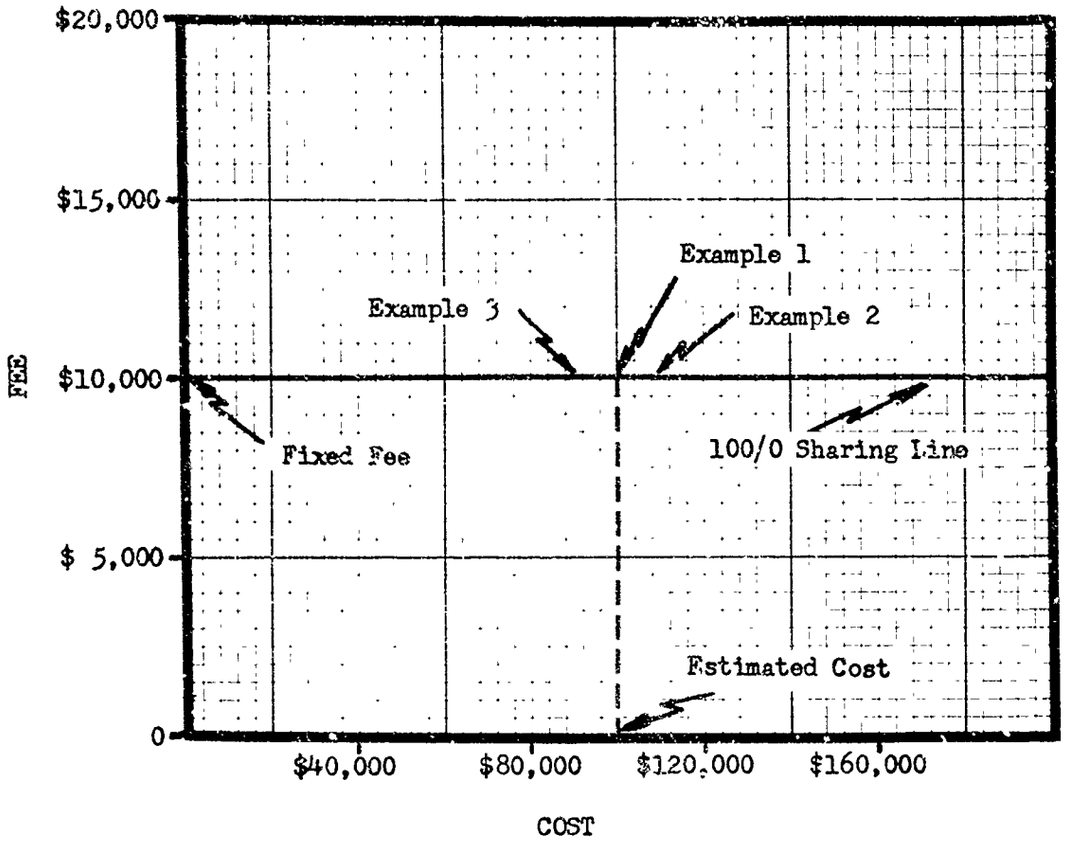
Fig. 2-1: Fixed price contract: Cost--profit curve for a contract having a price of $110,000.

CPFF contract. Under a CPFF contract the customer agrees to reimburse the contractor for all allowable costs plus a predetermined fee. In cost type contracts, the term fee is used rather than the term profit which ASPR reserves for fixed price type contracts. The fee is normally stated as a percentage of the target cost. The target cost is the cost agreed to in advance by both parties as being the most likely to accrue under the circumstances of a specific procurement. Figure 2-2 relates cost and fee for a CPFF contract having a target cost of $100,000 and a fee of $10,000. Since the fee is a fixed amount, the line is called a 100/0 share line. The customer is fully responsible for the actual cost. Included below the graph are three examples of cost outcomes to show the independence of cost and fee. Example 3, for instance, is the cost-fee point for an accrued cost of $90,000 and the fixed-fee of $10,000. This type of contract is said to provide the contractor with no direct incentive; i.e., tangible benefits, to control his costs.

Incentive Contracts

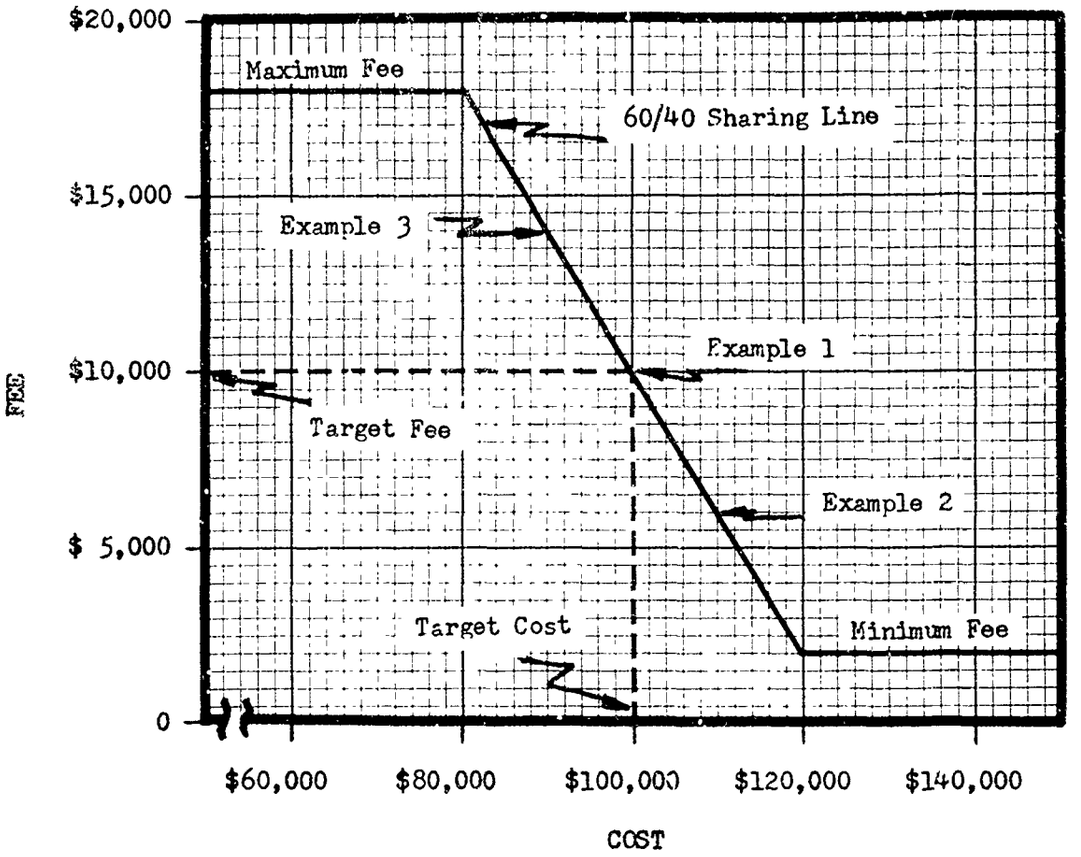
An incentive contract may be described by its elements: target fee, target cost, sharing formula, and limits. The sharing formula is usually shown as a ratio such as 70/30 or 60/40. The numerator represents the customer's share and the denominator represents the contractor's share of any deviation from cost target. In the FPI contract the limit is an upper limit on price. In the CPIF contract upper and lower limits are established on the fee and these limits define the Range of Incentive Effectiveness (RIE).

Figure 2-3 depicts a CPIF contract with a $100,000 target cost, $10,000 target fee, 60/40 sharing ratio, an RIE from $80,000 to $120,000,



Examples	1	2	3
Target Price	$110,000	$110,000	$110,000
Actual Cost	100,000	110,000	90,000
Actual Fee	10,000	10,000	10,000
Actual Price	110,000	120,000	100,000
Actual Fee %	10.00%	9.09%	11.11%

Fig. 2-2. Fixed fee contract: Cost--fee curve for a contract having a fixed fee of $10,000.

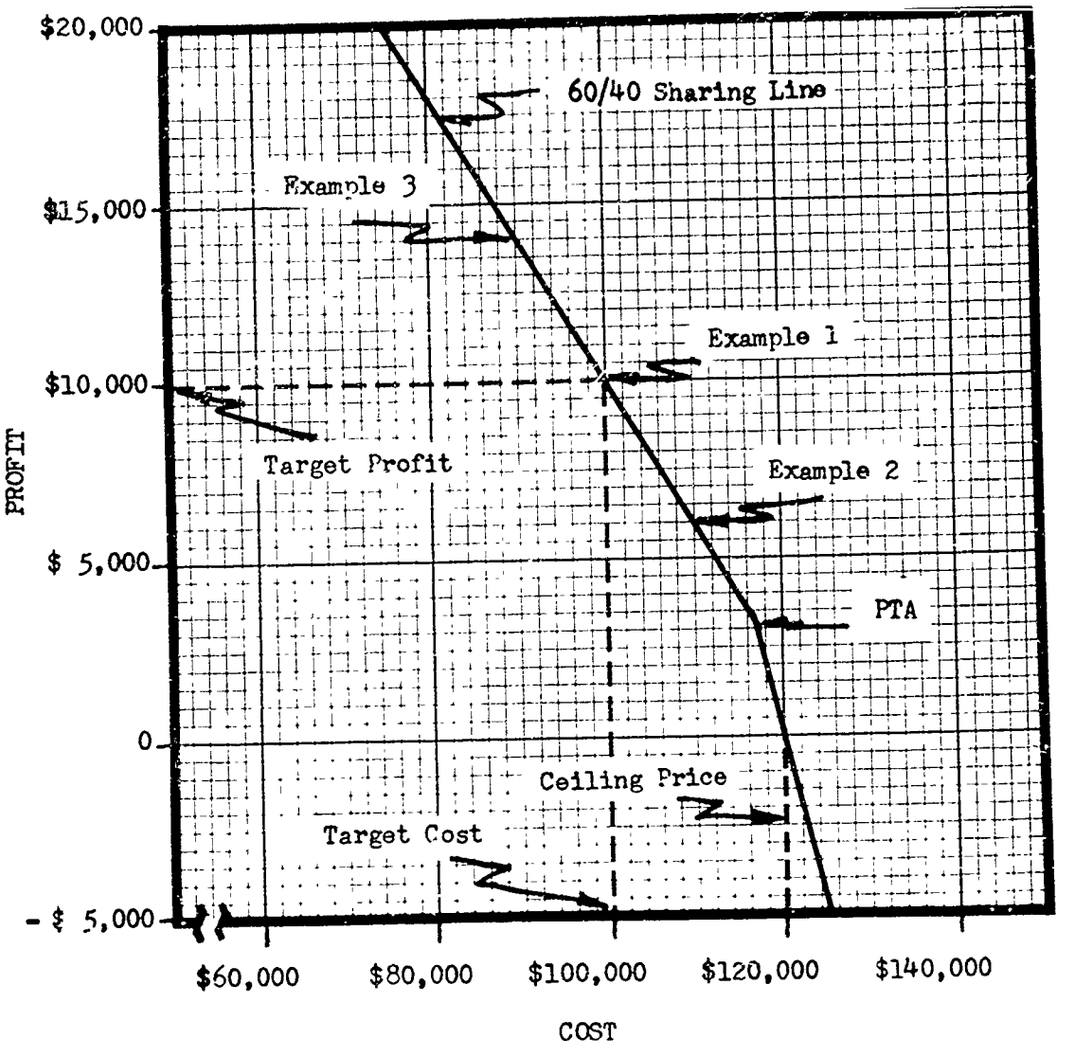


Examples:	1	2	3
Target Price	$110,000	$110,000	$110,000
Actual Cost	100,000	110,000	90,000
Actual Fee	10,000	6,000	14,000
Actual Price	110,000	116,000	104,000
Actual Profit %	10.00%	5.45%	15.56%

Fig. 2-3: Cost plus incentive fee contract: Cost--profit curve for a contract having a 60/40 share ratio.

and fee range from $2,000 to $18,000. The solid line represents all possible fee and cost outcomes. The 60/40 sharing is effective between cost outcomes of $80,000 and $120,000. Outside of this RIE the contract essentially becomes CPFF. Figure 2-4 illustrates a FPI contract with a $100,000 target cost, $10,000 target profit, 60/40 sharing ratio, and ceiling price of $120,000. As in the previous contract diagrams the solid line represents all possible profit and cost outcomes. It is important to note the specific differences in Figures 2-3 and 2-4. With a cost outcome under $80,000 or over $120,000 the CPIF contract constructively becomes fixed-fee. The sharing ratio is effective only between these preestablished cost limits. An additional term, point of total assumption (PTA), is introduced with the FPI contract. The PTA is the cost outcome beyond which the share ratio ceases to operate and the contract constructively reverts to a FFP basis with the ceiling price becoming the fixed price. Thus, the FPI has no guaranteed minimum profit. Graphically, the PTA is the intersection of the 0/100 share line passing through the ceiling price at zero profit and the automatic share line passing through the target cost at target profit.

It is interesting to compare the results of similar cost outcomes for the FPI and CPIF examples. With cost outcomes between $80,000 and $116,667 the price related to any particular cost outcome is the same for the FPI and the CPIF contracts. Beyond these limits, differences exist. For example, with an actual cost of $75,000 the CPIF price would be $93,000 (cost plus maximum fee) and the FPI price would be $95,000 (target fee plus 40% of the underrun plus cost). With an actual cost of $125,000 the CPIF price would be $127,000 and the FPI price would be $125,000.



Examples:	1	2	3
Target Price	$110,000	$110,000	$110,000
Actual Cost	100,000	110,000	90,000
Actual Profit	10,000	6,000	14,000
Actual Price	110,000	116,000	104,000
Actual Profit %	10.00%	5.45%	15.56%

Fig. 2-4: Fixed-price-incentive contract: Cost--profit curve for a contract having a 60/40 share ratio.

Multiple Incentives

The preceding FPI and CPIF examples include an incentive on the cost outcome. Other features of the contract may also be subject to incentive provisions; for example, the delivery schedule or any particular performance characteristic(s) the procuring agency wishes to emphasize. Contracts containing provisions for incentives on more than one element are called multiple-incentive and can be structured in an almost limitless variety of ways. ASPR does require that in order to have incentives other than cost, cost incentives must also be included. Table 2-1 lists certain contractual incentives contained in thirteen major procurements. These incentives are on the performance dimension and represent sizeable fee swings. In addition to cost and performance incentives these procurements also have incentives on schedule. For example, the C-5A contract calls for a penalty of $12,000 per day for late delivery on each of the first sixteen aircraft up to a total schedule penalty of $11 million. (156:5) An interim schedule incentive was included in the F-111 contract. The first successful flight test of the moveable wings was conducted ahead of schedule and resulted in an $875,000 "bonus" for General Dynamics. Fortune notes that this sum represents approximately four and one half cents per share of General Dynamics stock. (114:76)

The interdependencies of incentives in major multiple incentive contracts are extremely complex. So complex, in fact, that sophisticated tools for the construction and analysis of the incentive combinations have been developed by DOD and NASA. They include the Tabular Model (41:73-93), Planned Interdependency Incentive Method (48:302-306), and the Isofee Analysis System devised by a group from the Air Force Academy (23).

TABLE 2-1

EXAMPLES OF PERFORMANCE INCENTIVES ON RECENT MAJOR PROGRAMS

Contractor and Project	Maximum Incentive Reward (+)	Maximum Incentive Penalty (-)	Contractor's Total Stake In Performance
General Dynamics F-111	$26,250,000	$8,750,000	$35,000,000
Lockheed C-5A	22,500,000	. . . . .	22,500,000
Martin Titan 3	9,905,000	8,490,000	18,395,000
Ling-Temco-Vought A-7A	. . . . .	6,000,000	6,000,000
North American Minuteman Guidance System	4,947,558	4,947,558	9,895,115
Sylvania Minuteman Ground Station	1,200,000	1,200,000	2,400,000
Western Electric Nike X	2,501,000	2,501,000	5,002,000
TRW Systems Vela Satellite	675,000	675,000	1,350,000
Ling-Temco-Vought Lance Missile	2,450,000	2,450,000	4,900,000
Hughes Phoenix Missile	4,147,576	4,147,576	8,295,152
General Dynamics Redeye Missile	415,604	416,404	832,008
North American B-70 Flight Tests	775,000	775,000	1,550,000
Westinghouse Mk. 48 Torpedo	7,930,000	478,000	8,408,000

Source: Aviation Week and Space Technology, February 21, 1966. p. 101.

An Example

A relatively straight forward set of contractual provisions is shown in Table 2-2. The identity of the nationally prominent space program is intentionally withheld. This example was included because it contains incentives on cost, schedule, and performance. Note that the performance incentive is based on a figure of merit which is defined as the ratio of commands executed to commands given. The target is 80%. The schedule incentive is structured to penalize for late delivery and not to provide rewards for early delivery.

Cost-Plus-Award-Fee Contracts

The cost-plus-award-fee (CPAF) contract is a cost reimbursement type of contract having a variable fee. The fee is not computed on the basis of an automatic share ratio as in the CPIF contract. Rather, the award fee is a "variable fee based on criteria in which purely objective calculations are not possible and the fee therefore is based upon the application of subjective judgments [made] by designated high-level, Government personnel on the basis of periodic, after-the-fact evaluations of the contractor's performance." (51:1)

The theory is that certain procurements such as those for launch support services and the operation, maintenance, logistic, and engineering services are not amenable to an automatic cost sharing formula. A variable award fee is designed to motivate a high level of performance in the procurement of services and, in some cases, hardware when the usual incentives are not applicable.

The elements of a CPAF contract are estimated cost, base fee, award fee, maximum fee, and performance criteria. The base fee is some

TABLE 2-2

COST, SCHEDULE, AND PERFORMANCE INCENTIVES

IN AN AIR FORCE SPACE CONTRACT

Incentive Mode	Method of Computation	Fee Swing
Cost	80/20 Share Ratio	± $930,000
Schedule	Each of the seven satellites may be penalized according to the following: Days Late — Penalty 0-7 — 0 8-14 — $ 5,000 15-21 — 10,000 22-28 — 15,000 29-35 — 20,000 $20,000 per 7 days thereafter up to a total of $66,429.	- 456,000
Performance	Each of the seven satellites may be penalized according to the following: Figure of merit = Commands Executed / Commands Given Figure of Merit — Fee Differential 1.0 — + $132,857 .9 — + 66,429 .8 — 0 .7 — - 66,429 .6 — - 132,857	± 900,000

Source: Air Force Contract Summary.

fixed amount, normally in the range of zero to three percent of the estimated cost. The award fee is a variable dependent upon outcomes as measured against the performance criteria and is added to the base fee. The maximum fee is the sum of the base fee and the maximum possible award fee. The critical element is the performance criteria which must be clearly defined to be meaningful. Possible areas which may be included in the criteria are such items as timeliness, quality, and cost performance of the work orders or goals in the contract. An example used in the NASA CPAF guide includes the following criteria: (51:19)

a. Timeliness of response

$$\frac{\text{Number of work orders completed on time}}{\text{Total number of work orders}} \times 100 = \%\ \text{completed on time}$$

b. Quality of work

$$\frac{\text{Number of work orders accepted on first inspection}}{\text{Number of work orders inspected}} \times 100 = \%\ \text{accepted on first inspection}$$

c. Effectiveness of cost management

$$\frac{\text{Number of work orders completed within 10\% of estimated cost}}{\text{Number of work orders completed}} \times 100 = \%\ \text{completed within estimated cost}$$

Although not included in ASPR until 1968, the CPAF contract is not new. As presently structured it has been applied extensively by NASA and on a test basis by the Army, Navy, and Air Force since the early sixties. Early applications included the Navy's award fee for a portion of a logistic support contract for operations at Kwajalein Island and NASA's contract for operation, maintenance, and engineering services for the Mercury Manned Space Flight Netwo (51:5-6)

Combinations of the CPIF and CPAF types may be constructed. This provides a great flexibility in creating a contract to fit a particular procurement situation.

Selection of the Correct Contract Type

The degree of cost certainty is the key factor influencing the selection of the type of contract to use for a given procurement. ASPR states that the FFP is the most preferred type of contract. The most recent DOD and NASA incentive guide recommends consideration of:

> (i) the definitiveness of the project at this stage and its bearing on the accuracy of cost estimates; (ii) the completion schedule required for satisfactory operational deployment; (iii) the degree of uncertainty expected; (iv) the contractor's willingness and ability to accept a high-risk type of contract; (v) the ability to establish meaningful and measurable incentives; (vi) the need for effort overlapping that of earlier development stages; (vii) the desirability of firm technical direction by the government; and (viii) the degree of configuration control to be exercised. Any one or combination of these factors could have a direct bearing on the type of contract selected. (48:8)

Concluding Remarks

The vast array of goods and services required to support the government's defense and space interests necessitates the need for a wide spectrum of contract types. Certaintly the use of the wrong type of contract for a specific procurement could result in the improper division of risk between the contractor and the government. This chapter has briefly introduced the major contract types, and it has emphasized the motivational aspects of automatic incentives. DOD and NASA believe that by shifting, whenever possible, from CPFF to incentive and from incentive to FFP contracts additional profit making opportunities will be created for the contractor. These opportunities will motivate him to increase his earnings while simultaneously providing a lower price to the government customer.

CHAPTER III

PROFITS, OBJECTIVES, AND LIMITS

> Of all the myriad aspects of business and finance, no single one is more misunderstood than the role of corporate profits in our economy. -- Dun's Review (113:34)

Profit is only one element of the contract price. It is a special element in that it does not flow through the contractor's hands in payment for the material or labor, no matter how indirect, consumed by the specific contract for which it is paid. Rather, it is a source of funds from which a return to the owners of the capital employed in the firm is drawn as well as an internal source of capital to provide for the continued growth of the firm. Thus this atypical element of the overall price receives an improportionate share of interest from theorists and practitioners alike.

If profit maximization is the primary goal of the defense and space industry and if profit is without bounds, then the consideration of the role of profit in procurement is rather straightforward and amenable to rigorous mathematical theory and modeling. The economics and business literature is abundant with argument concerning the propriety of the profit maximization assumption. Further, pressures from a variety of sources such as buyer resistance and substitutes serve as an upper limit on profits while the continued existence of the firm serves as a lower limit.

This chapter is included to place profit in the perspective of the current concepts of organization objectives and in the context of the government procurement environment. It examines the question of the role of profits in the large defense and space corporations and the question of the limits on profit. It does not attempt to investigate the adequacy of any specific profits levels or a theoretically "proper" profit.

Economists Views on the Role of Profit

One of the most fundamental assumptions of "classical" economics is that of the profit maximizing firm. Implicit in this assumption is a notion of what motivates all industry. Milton Friedman, as quoted by Galbraith, strongly asserts that "Few trends could so thoroughly undermine the very foundation of our free society as the acceptance by corporate officials of a social responsibility other than to make as much money for their firms as possible." (4:113) Henderson and Quandt state that ". . . his [the entrepreneur's] ultimate aim is the maximization of profit rather than the solution of constrained maximum and minimum problems." (5:53) They subsequently extend the theory to firms with multiple inputs and multiple outputs. Vickrey echoes, "The activities of the firms are conceived to be carried out with the goal of maximizing the 'profit' of the entrepreneur." (21:145) More examples could be provided which illustrate the same assumptions, but it is sufficient to assert here that a noninconsequential group of economists hold the assumption that a firm's objective is to maximize profits.

Reservations about the profit maximizing assumption are creeping into modern economic literature. In his widely read introductory text Samuelson discusses the issue as follows:

> To what degree do businessmen actually try to maximize their profits? . . . those firms which actually do manage to survive cannot be completely oblivious to the maximization of profits. . . . As soon as it becomes of any considerable size [emphasis supplied] it can afford to relax a little in its maximizing activities. (13:544)

Baumol expressed doubts in saying that "There is no simple method for determining the objectives of the firm." (1:295) He points out that certain commonly assumed plausible goals can lead to inconsistencies and then, even so, says, "it is most [emphasis supplied] frequently assumed in economic analysis that the firm is trying to maximize its total profits." (1:296) He opens the door for alternative objectives but returns to the classical objective of profit maximization.

Scitovsky also has qualms about profit maximizing as the paramount motive for the firm. He admits that:

> the actual behavior of firms often seems to be at variance with what one would expect their behavior to be on the assumption that they aim at maximizing profit; and this seeming incompatibility between the firm's actual market behavior and the economists' theory of his behavior has led to a growing demand for a new and more realistic theory of the firm. So far, no such new theory has been developed and none will be presented here. (15:111)

So he recognizes the issue, expresses a need, and then dismisses the problem leaving the reader unsatisfied and with no alternative other than to accept profit maximizing theory or seek another authority.

In describing the New Industrial State John Galbraith strongly warns that "The defenders of maximization are seen to be perpetuating, no doubt innocently, a rather subtle trick. Profit maximization may be assumed. But as a concession to reality the industrial system--the largest, most typical and most modern part of the economy--is excluded." (4:123) Galbraith proposes just such a theory as was identified as

missing by Baumol, Scitovsky and others. Central to an understanding of Galbraith's ideas on corporate motivation is his definition of the term "technostructure". Basically the technostructure is the large group of people in a mature industrial enterprise that replace the entrepreneur as the directing force of the enterprise. He points out that it embraces individuals ranging from corporate chairman to division and departmental heads and that a precise delineation of membership is not easily found but that it exists implicitly. This technostructure is then said to dominate the large mature corporations which themselves dominate U. S. industry. (4:71-73)

After thoroughly berating the profit-maximization assumption and identifying it as a convenient "simplification" used by theoretical economists to avoid reality, he offers his own version of reality in its stead. He presents a "principle of consistency" which is defined as a "deeply interconnected matrix of relationships between goals of society, the organization, and individuals." He effectively defines this principle as the need for consistency throughout this matrix. Because of the consistency he says, "More specifically, the goals of the corporation will be a reflection of the goals of the members of the technostructure." Galbraith identifies the goals of the mature corporation as survival, autonomy, growth as measured in sales, and technological virtuousity (capacity for innovation). He defends this list with an argument based on the consistency principle outlined above. (4:159-178)

Profit and Goals of the Firm

Even business publications such as The Wall Street Journal and Fortune have seriously questioned the profit maximizing assumption.

Such statements as "The idea that businesses always maximize profits for one thing, is far from being an undisputed axiom of economics," (97:1) and ". . . businessmen have pretty much abandoned one familiar old formulation that used to be very popular; the view that corporations do the most good for society when they just stick to business and maximize their own profits" (86:89) are strong signals from the business world.

American Telephone and Telegraph's John Scanlon suggests that ". . . managements fundamental responsibility is to manage the business in the best long-term interests of the firm's investors, its customers, its employees, and the nation's general welfare." (122:14) This broad sense of responsibility is not universally accepted. According to Vice Admiral Hyman G. Rickover:

> Business exists to make profit. That is its primary purpose regardless of the large number of speeches being made by business leaders--where they say that their constituency consists of the government, the public, the local community, their employees and their stockholders, and that their loyalties encompass all these constituencies. (33:68)

This divergence is evidenced in the press, public presentations by government and industry spokesmen, internal business memos, and scholarly inquiries.

Perhaps it is best summarized by Scherer in concluding that firms have a variety of goals held collectively or individually by those people comprising the firm. He further states that some of these goals are inconsistent with others while yet others are reinforcing. He suggests the following as at least a partial list of goals: (14:7)

1. Maximization of profits
2. Organizational survival

3. Growth of sales and employment

4. Security of employment, sales, and profits

5. Freedom from harassment

6. Desire for public approbation

7. Desire to contribute to the national defense

8. Desire to advance science and technology

The Armed Services Procurement Regulation sets forth the DOD's position on the role of profit. It is a strong reflection of the more traditional viewpoint:

> Profit, generally, is the basic motive of business enterprise. Both the government and its defense contractors should be concerned with harnessing this motive to work for the truly effective and economical contract performance required in the interest of national defense. ASPR 3-402 (a) (1)

Profit Limits: The Contractor's View

The diversity of goals suggested in the preceding section presents an extremely complex set of feasible policies from which the defense and space contractor may select his profit strategy. The goals suggest that the contractor's profit strategy may be directed to a range of profits having fairly definite upper and lower limits. This section considers the following list of contractual and extra-contractual factors which impact the definition of these limits:

1. Contractual

   a. Statutory limits

   b. Renegotiation

   c. General Accounting Office

2. Extra-contractual

   a. Congressional investigations

b. Prestige and reputation of the firm

c. Follow-on business

d. Flight of capital

e. Source of funds

Statutory Limits

For CPFF contracts, 10 U.S.C. 2306 (d) legally limits the maximum fixed fee. This limit is 10% of the estimated cost of the contract. Two exceptions to this limit are 15% for experimental, developmental, or research work and 6% for certain architectural or engineering services for public works. Thus, a very definite statutory upper limit exists for certain individual contracts.

Renegotiation Board

The U.S. Renegotiation Board's stated purpose is the ". . . elimination of excessive profits on government contracts and related subcontracts . . ." (55:1) Contractors whose annual renegotiable sales (government contracts and related subcontracts less numerous exceptions) are over $1 million are required to file reports with the Board. In fiscal year 1968, 4,552 firms were above this limit. An additional 2,328 firms filed voluntarily. (55:6) The Renegotiation Board, in its examination for excess profits, considers all of a contractor's renegotiable business for the contractor's fiscal year rather than on a contract by contract basis. In its deliberations it considers reasonableness of costs and profits, sources of capital, extent of risk, nature and extent of contribution to the defense effort, character of the business, and other factors. (55:5) It does not use strict "across-the-board" limits in its rulings.

It is interesting here to note the net renegotiable profits reported to the Renegotiation Board by contractors for fiscal year 1968. This pre-renegotiation data is included in Table 3-1 by type of contract. The allowances of the Board for costs differ from those allowed by the procuring agency and therefore the data in Table 3-1 must be used with care.

TABLE 3-1

NET RETURN ON RENEGOTIABLE SALES--1968[a]

(in millions of dollars)

Type of Contract	Sales	Profits[b]	Return on Sales
Firms Reporting Net Renegotiation Profits			
FFP	$19,611	$1,228	6.2%
FPI	3,822	227	5.9
CPIF	4,641	214	4.6
CPFF	5,258	182	3.5
Other	1,927	59	3.1
Firms Reporting Net Renegotiation Losses			
FFP	2,838	(187)	(6.6)
FPI	140	(16)	(11.4)
CPIF	23	(2)	(8.7)
CPFF	297	(2)	(0.7)
Other	215	(8)	(3.7)
Firms Combined			
FFP	22,449	1,041	4.6
FPI	3,962	211	5.3
CPIF	4,664	212	4.5
CPFF	5,555	180	3.2
Other	2,142	51	2.4

[a] Source: U. S. Renegotiation Board, Fifteenth Annual Report, USGPO, December 31, 1968, p. 9.

[b] Profits before renegotiation.

The literature on the Renegotiation Board is extensive and therefore the comments here are abbreviated. They were included to illustrate that the Board's activities definitely serve as a "real world" constraint on contractors' profits.

General Accounting Office

One of the responsibilities of the General Accounting Office (GAO) is to report to Congress regarding the ". . . effectiveness of contracting agencies and contractors in carrying out their management and financial responsibilities . . ." (9:20) GAO audits advertised procurements having changes over $100,000 and all negotiated contracts. Their audits are not limited to specific contracts--the GAO typically examines small portions of a contract or contractor management actions which may apply to all of the firm's business. In the major contractor facilities such as Lockheed and General Dynamics the GAO maintains a full time staff of accountants. Their studies have included such topics as the allowability of cost for a contractor's executive aircraft and the acceptability of a contractor's decision to lease rather than purchase his electronic data processing equipment.

Much has been written about the GAO and its role in defense and space procurement. Perhaps the best reference is The Government Contractor and the General Accounting Office published by the Machinery and Allied Products Institute. (9) In addition to tracing the history and authority of the GAO it discusses a sample of recent investigations from three points of view: the contractor, the government procuring agency, and the GAO.

Extra-Contractual Influences

No contractor makes decisions based solely on the framework of a single specific contract. He must consider such diverse influences as the Congress, general public, procuring agency, potential procuring agencies, owners of capital, and potential capital sources.

It is obviously not the purpose of this section to provide a detailed discussion of business policy. Rather, it is sufficient here to assert that a host of extra-contractual influences exist which bear on the actions taken in the conduct of business. Firms must satisfy the owners of the capital employed or risk the flight of capital to another firm or another industry. Extremely high profits will result in a flow of capital into the industry and thereby increase competition. Firms must generate capital for growth. Firms do not relish extensive Congressional inquiries with the concommitant potential of adverse publicity. Firms seek prestige for many reasons. These considerations and certainly others serve to establish lower and upper limits on the profit strategy of the firm and thus must be considered as constraints within which the automatic contractual incentives may be effective.

Profit Limits: The Customer's View

Although the DOD and NASA publicly state that their pricing objective is to pay a fair price for the goods and services procured, they too have external influences which tend to define upper and lower limits on the profits they are willing to pay. It is interesting to note that many of these limiting influences on DOD and NASA are the same as those which limit the contractor. These influences include:

1. Contractual

   a. Statutory limits

   b. Renegotiation

   c. General Accounting Office

2. Extra-Contractual

   a. Congressional criticism

   b. Sensitivity to the public

   c. Flight of capital

   d. Contract management personnel

The contractual limits operate for the government as they do for the contractor and hence require no further discussion here. What is important is to recognize that they are constraints and that they do bound the potential profit range.

Extra-Contractual Limits

The popular press relishes in revealing situations in which the government organizations are alleged to have handled public funds in a questionable manner. The procurement personnel at all levels are certainly sensitive to this source of criticism from the public as well as other sources such as the Congress. This sensitivity itself serves as a damper on the range of possible profits.

The need for the continued existence of a healthy defense and space industry is a factor which definitely serves as a lower limit on profits. If a reasonable return on the industry's investment is not forthcoming, the industry cannot remain responsive to the demands of the government. That is not to say that the government is required to keep a particular firm or set of firms in business. Rather, the government must insure that its practices do not unfairly injure the industry.

An additional factor must be considered as a profit limiter. That factor is comprised of the thousands of government employees who participate in contract negotiations and other contract management functions. That these contract management personnel are sincerely attempting to provide responsible government representation is not questioned. The problem is one of measurement. This was recognized by former Secretary McNamara and conveyed by him in a statement to the Senate Armed Services Committee. (47:199) As Sumner Marcus discussed the problem in the Harvard Business Review:

> Many contracting officers choose the expedient solution to their quandry; through experience, they arrive at a profit or fee rate that is well below the maximum permitted but high enough that the contractor will accept it, and they use these few rates over a long period for all contracts they negotiate, regardless of contractor or situation. As time goes on they tend to lower the rate slightly, to establish themselves as good bargainers. . . . The virtues of the 'magic number' system are obvious: the contracting officer has little risk of spurring an investigation . . . if the rate is stable and trending downward, the contracting officer's superiors (who are in a poor position to evaluate the reasonable nature or the costs) are pleased at what appears to be hard bargaining, and finally, the contractor feels some sense of continuity--the known fee of today may be better than earnest negotiation on each contract may yield tomorrow. The drawback to this system is that it tends to become universal and ignores the individual characteristics of each situation. (106:22)

Concluding Remarks

Economists, industry leaders, and government officials have a variety of viewpoints on the role of the profit motive. These viewpoints set the stage for an analysis of contract outcomes in an incentive environment.

Profit is certainly not an unconstrained element of the price of goods or services. Contractors face a host of upper and lower limits on

their profits. Some of these limits are explicitly included in government contracts while others reflect pressures from extra-contractual sources. The government, as party to a contract, similarly is limited by contractual and extra-contractual constraints on the amount of profit with which it may reward industry. These include both upper and lower profit limits. The results of the industry profit analysis of Chapter 4 and the contract outcome analysis of Chapters 5 and 6 must be considered in light of these constraints.

CHAPTER IV

INCENTIVE ENVIRONMENT OUTCOMES - A MACROSCOPIC ANALYSIS

One possible way of assessing the results of incentive contracts is to examine the profits of those firms heavily involved in defense and space business. The purpose of this chapter is to do just that. Of course, it is impossible to examine the profitability, over time, of the thousands of firms selling to the DOD and NASA. Due to the concentration of defense sales it is possible to examine, in detail, the profitability of a selected group of contractors and conclude, in a macroscopic sense, the result of the switch to a much larger percentage of incentive and fixed-price contracts.

This chapter first examines the concentration of defense sales by contractor and by contract dollar value. It describes how the Fortune 500 firms are grouped by their sales concentration on defense and space contracts. Various financial ratios are then studied for these groups. The ratios include return on sales, return on assets, return on net worth, total capital turnover, equity capital turnover, and sales dollars per employee. The trends of these ratios are then analyzed to determine the impact of the incentive environment.

Concentration of Defense and Space Market

The defense and space market is certainly not characterized by the

large number of sellers and the large number of buyers requisite for a competitive market. Of course there are thousands of firms, large and small, which sell to the DOD and NASA. However, only a relatively small number of these firms share a significantly large portion of the billions of contract dollars awarded each year.

The distribution of the percentage of contract dollars shared by each of the top four groups of twenty-five firms and all others is detailed in Table 4-1. In 1968 nearly 46% of the $38.8 billion of DOD contract awards went to only twenty-five firms. One firm, General Dynamics, accounted for 5.8%. The five firms obtaining the largest share of defense spending obtained an impressive 20.6%, nearly seven billion dollars. The top 100 firms continually account for approximately two-thirds of all defense contract dollars. The sharing between groups has remained fairly stable throughout the years.

The distribution of NASA's contract dollars is even more unbalanced. In 1968, for example, 24.3% of NASA's $3.4 billion of contract awards went to <u>one</u> firm. The top five firms received nearly 56% of the dollars while the top 100 firms accounted for over 92%. (50)

The nature of the goods purchased by DOD and NASA is responsible for skewed distribution of contract dollars. The major weapon and space systems account for many millions of dollars each. Few firms have the manpower, physical capacity, and technological virtuousity required to participate in the research, definition, and production cycle for major systems. Thus, names such as General Dynamics, Lockheed, United Aircraft, McDonnell-Douglas, Boeing, and North American Rockwell appear year after year in the roster of firms obtaining the largest portion of DOD and NASA

TABLE 4-1

PERCENTAGE OF DOD PROCUREMENT DOLLARS[a]

AWARDED TO CONTRACTORS RANKED BY DOLLAR SHARE (FY 1959-1968)[b]

Rank of Company	Fiscal Year									
	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
1 - 25	54.6%	53.5%	54.8%	50.8%	51.9%	52.9%	48.2%	43.0%	44.5%	45.6%
26 - 50	10.7	11.3	11.0	12.6	13.7	12.9	13.0	12.1	11.6	11.5
51 - 75	5.5	5.4	5.5	6.0	5.5	5.1	5.2	5.4	6.1	6.6
76 - 100	3.0	3.2	2.9	2.9	2.8	2.5	2.5	3.3	3.3	3.7
All other	26.2	26.6	25.8	27.7	26.1	26.6	31.1	36.2	34.5	32.6

[a] All procurement actions of $10,000 or more.

[b] Source: 100 Companies and Their Subsidiary Corporations Listed According to Net Value of Military Prime Contract Awards, Directorate of Statistical Services, Office of the Secretary of Defense, various issues.

dollars. In his recent Senate testimony, Professor Murray Weidenbaum discussed the turnover among the major defense contractors. He found that of the top 25 firms in 1957, 21 were in the top 25 in 1966 and three were in the second group of 25. He concluded the "The relatively low turnover among the top firms in the military market . . . results in good measure from the substantial barriers to both entry into and exit from the markets for major weapon systems." (154:6) He further found that firms having smaller shares of the defense market have a much higher turnover on the roster of major defense suppliers.

An additional approach to highlighting the concentration of defense and space sales is to consider the skewed distribution of defense dollars per contract. In fiscal year 1967 there were 229,354 contracts awarded each having a price of $10,000 or more. These contracts represented a total of over $39 billion. A mere 0.2% of the contracts accounted for 30.9% of the dollars. Over 80% of the dollars were awarded for only 10% of the contracts. Contracts having a price of $25,000 or more represented over 30% of the awards and nearly 96% of the dollars. Table 4-2 provides the complete distribution of contract quantities and dollars.

With a concentration of defense and space contracts in the large dollar awards and in a small group of firms it is possible to focus this research on high value contracts and a relatively small number of contractors. The remainder of this chapter is devoted to an examination of the measures of profitability of a specific group of defense and space contractors. Chapters 5 and 6 examine the cost and profit outcomes of a large group of high value contracts.

TABLE 4-2

MILITARY PRIME CONTRACT AWARDS BY SIZE

(Fiscal Year 1967)

Size in Dollars	Contracts		Dollars	
	Cumulative Number	Cumulative Percent	Cumulative Amount in Billions	Cumulative Percent
$10,000,000 or More	475	0.2%	$12.2	30.9%
5,000,000 or More	1,045	0.5	15.9	40.5
2,000,000 or More	3,066	1.3	21.7	55.3
1,000,000 or More	6,036	2.6	25.5	65.1
500,000 or More	11,161	4.9	28.8	73.4
300,000 or More	16,972	7.4	30.8	78.6
200,000 or More	23,113	10.1	32.2	82.0
100,000 or More	38,121	16.6	34.1	86.8
50,000 or More	69,366	30.2	36.1	91.9
25,000 or More	119,426	52.1	37.7	95.9
10,000 or More	229,354	100.1	39.3	100.0

Source: Military Prime Contract Awards Size Distribution, Directorate for Statistical Services, Office of the Secretary of Defense, December 18, 1967.

The Fortune 500

Each year Fortune publishes a listing of the 500 largest, by total sales, industrial corporations. The primary criterion for inclusion in the Fortune 500 is that at least half of a firm's revenues must come from manufacturing and/or mining. Summary financial data such as sales, assets, net worth, and net profit is included for each firm.

The majority of those firms in which defense and space sales are concentrated are included in the Fortune 500. For example, the Fortune published on June 15, 1968 contains 67 of the 100 firms receiving the largest number of fiscal year 1968 defense dollars. The 33 firms not included account for only 9.6% of the defense contract dollars. Utility, transportation, construction, and nonprofit consulting firms account for

20 of the 33 firms. The remaining 13 were not included in the Fortune 500 because their net sales were not sufficiently large. The Fortune 500 similarly contains the preponderance of the top 100 NASA contractors.

The Fortune 500 Divided

Since the summary financial data for the majority of those firms receiving the largest number of defense and space dollars is readily available it is computationally practicable to examine the profitability trends of those firms. Further, it is feasible to compute the profitability trends for similarly large corporations - the remainder of the Fortune 500. The trends of firms in the defense and space market can than be compared to similar trends of firms oriented toward the non-government market.

For this research, the Fortune 500 is divided into three groups. The basis of division into groups is the percentage of total sales represented by the combined DOD and NASA sales as reported in the annual DOD and NASA indices of their respective top 100 contractors. Average return on sales, return on net worth, return on assets, total capital turnover, equity capital turnover, and sales dollars per employee are then calculated for each group. The period includes the years 1956 through 1967. The first year, 1956, was selected, not because it was a particularly significant year, but because a sufficient number of years of pre-incentive environment data is required if "before and after" trends can be made. The groups are defined as follows:

Zero (0) - Firms not in the DOD and NASA 100 listings.

Low (L) - Firms whose DOD and NASA sales amounted to more than zero but not more than 50% of total sales.

High (H) - Firms whose DOD and NASA sales amounted to more than 50% of total sales.

The number of firms in each group for each year is listed in Table 4-3. Throughout the 1956-1967 period the number of firms in each group has not significantly varied. The reason that in several of the early years covered the total number of firms is slightly less than 500 is simply because some item of information was not made available to Fortune. Any firm for which an item of information was missing in any particular year was not included in any of the calculations for that year.

Government sales as a percentage of total sales remained fairly stable for all groups. This is evidenced in Table 4-4. If the percentage of government sales were uniformly distributed, the expected values for Groups L and H would be 25% and 75%, respectively. Group L actually has a mean of 17.3% and Group U 76.7%. It is interesting to note that the actual mean of Group L is significantly lower than the expected value. It must be emphasized that the government sales percentage computed for each firm is not a precise figure. Rather it is a conservative estimate used to group the firms. It is conservative in that it only considers procurement actions of $10,000 or more and it only includes direct government sales.

The firms in Group L are typically the largest industrial corporations. In 1967, for example, the 54 firms in this group experienced average sales of $2.6 billion. Their net worth and assets averages were $1.3 and $2.3 billion, respectively. The group having the next highest average sales level was Group H with $1.0 billion. Group O was composed of

TABLE 4-3

NUMBER OF COMPANIES IN GROUPS O, L, AND H

(1956-1957)

Year	Group O	Group L	Group H	Total
1956	424	49	18	491
1957	420	57	14	491
1958	426	50	20	496
1959	430	52	16	498
1960	429	52	17	498
1961	428	46	23	497
1962	429	50	20	499
1963	433	50	17	500
1964	431	53	16	500
1965	428	50	22	500
1966	431	51	18	500
1967	432	54	14	500

TABLE 4-4

ANNUAL AVERAGE DOD AND NASA SALES AS A PERCENTAGE OF TOTAL SALES FOR GROUPS L AND H

(1956-1957)

Year	Group L	Group H
1956	15.6%	75.2%
1957	17.1	86.0
1958	18.7	80.6
1959	18.8	75.7
1960	18.8	76.6
1961	18.0	75.4
1962	16.9	72.7
1963	15.5	74.2
1964	15.5	77.2
1965	14.8	76.6
1966	17.1	78.3
1967	20.4	72.[illegible]

the smallest of the Fortune 500. Its average 1967 sales were $479 million.

Profit and Return

An examination of the average net profit for firms in eacn Group reveals interesting trends. Complete data is included in Table 4-5. The trends demonstrate steady profit growth for firms receiving not more than 50% of their revenues from DOD and NASA. For Group H the trend is much less stable. Figure 4-1 compares the profit growth for Groups O and H. Since the absolute profit dollars for these two groups are so different the values for the first year of the period are set at 100% and trends are shown against that base. The exceptionally low 1960 profit for Group H is caused by severe losses sustained by General Dynamics, Lockheed, Douglas and others. The Lockheed loss of $42.9 million was due to the write-off of "development and engineering change costs on its Electra commercial transport and the Jetstar small transport." (149:41) Douglas "recorded company losses of $33.8 and $19.4 million in 1959 and 1960, respectively." (149:37) It is interesting to note that these major losses are due to commercial ventures.

Absolute profit dollars by themselves do not validate a firm's success. A large amount of accounting profit based on a very low sales volume may be more desirable than a small accounting profit based on a large sales volume. Similar statements about profit are true when the terms assets or net worth are substituted for the term sales. Therefore, to properly consider profitability trends, consideration must be given to "return".

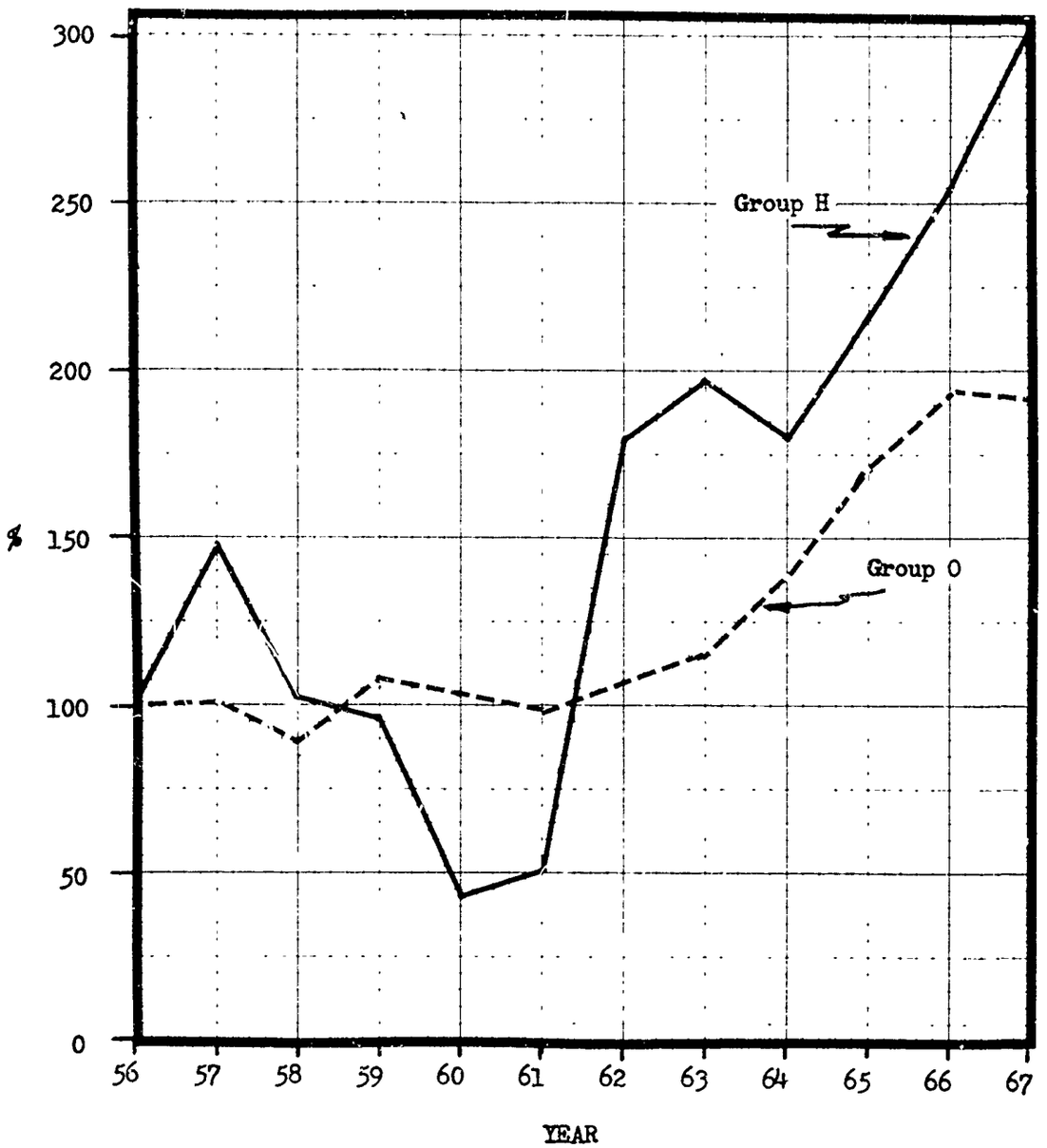


Fig. 4-1. Net profit trends for groups O and H (1956 = 100%).

TABLE 4-5

ANNUAL AVERAGE NET PROFIT FOR GROUPS O, L, AND H

(1956-1967)

Year	Group O	Group L	Group H
	(millions of dollars)		
1956	$14.3	$105.0	$10.1
1957	14.4	93.7	15.0
1958	12.8	78.1	10.3
1959	15.5	99.2	9.7
1960	14.9	98.4	4.5
1961	14.2	117.9	5.1
1962	15.4	130.6	18.1
1963	16.5	150.5	19.9
1964	19.7	160.0	18.2
1965	24.3	182.6	21.9
1966	27.6	190.5	25.7
1967	27.5	168.2	30.8

Return on Sales, Assets, and Net Worth

Return on sales, assets, and net worth are all guides used to measure profitability. According to Tucker:

> Manufacturing management regards profit as the earnings it makes on sales; the owners view profit as the earnings it makes on investment; those who look at profit more conservatively regard it as the return on the total resources used in the business, that is the total assets. The sales manager sees profits tied to volume. (20:255)

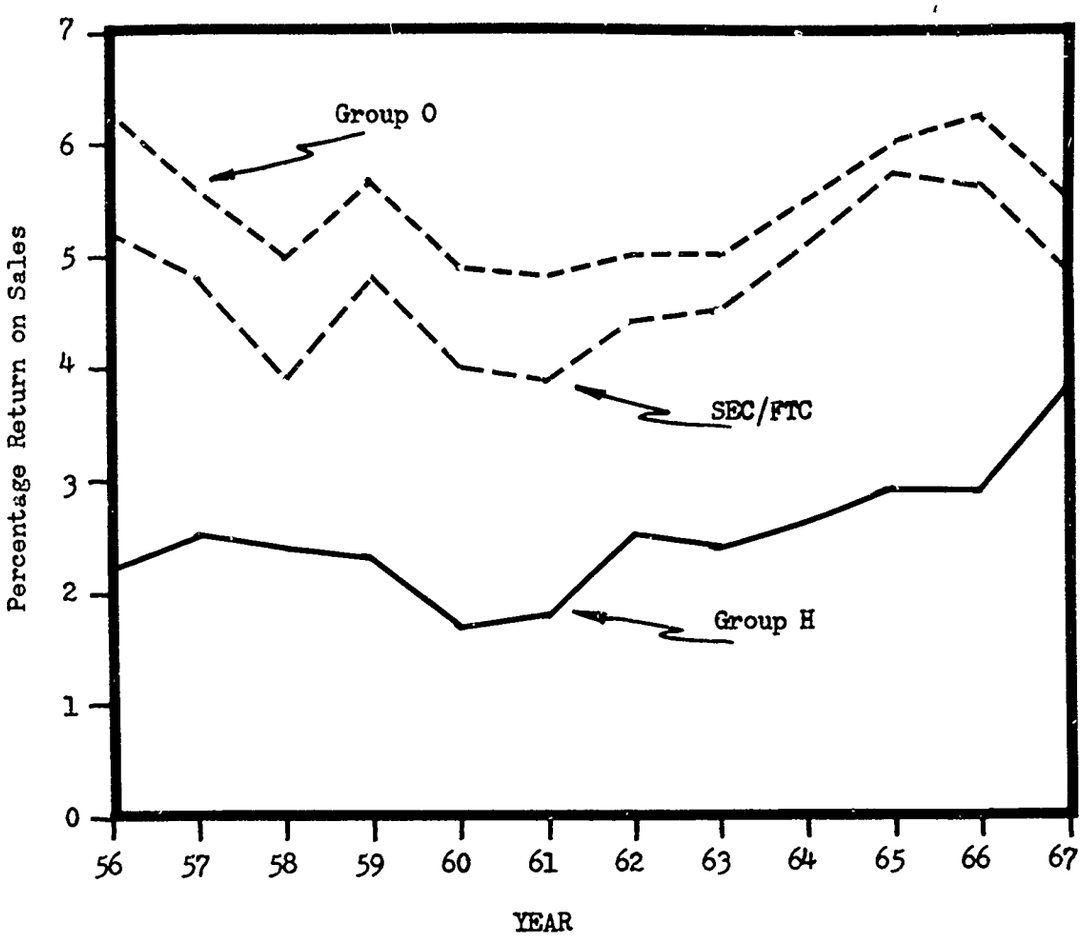
Strong differences of opinion exist regarding the appropriateness of using one of the ratios in lieu of the others. (146:15), (106:28), (17:157-159) The view used in this dissertation is that ". . . the isolated value of a ratio is not given as much importance as its movement from period to period and its interrelation with other ratios." (20:277)

Return on Sales

Trends of annual average return on sales for Groups O and H are shown in Figure 4-2. Also shown is a return on sales trend line based on the Securities Exchange Commission/Federal Trade Commission statistics for all durable goods manufacturers. Included below the graph is a tabulation of the return on sales percentages for Groups O, L, and H in addition to the SEC/FTC data. The trends are all comparably stable.

The return on sales percentage for those firms predominately oriented toward defense sales is consistently lower than the return earned by the other groups. With two exceptions, the return on sales for Group U remained stable within the 2.3% to 3.0% range. One exception is the 1960-1961 period which was previously discussed. The other exception is 1957 and is attributable to one firm which had a return on sales of 10.26%. If this one firm is eliminated, the average return on sales drops from 3.77% to 3.27%. The low return on sales percentage for Group H is undoubtedly the reason why aerospace industry spokesmen typically refer to this ratio as their figure of merit. (57:20,90) It is the ratio which may be used to support the position that the aerospace industry profitability is the lowest.

The average return on sales for firms having little or no DOD and NASA sales is slightly more than twice the same return for firms in Group H. The return on sales percentage trend for the SEC/FTC firms, although paralleling the trend for Group O, remains approximately one percent lower. This is because the SEC/FTC group includes data for firms regardless of the firms DOD and NASA sales percentage.



Group O	6.3%	5.6%	5.0%	5.7%	4.9%	4.8%	5.0%	5.0%	5.5%	6.0%	6.2%	5.5%
Group L	6.8	5.8	4.7	5.5	5.2	5.9	5.7	6.0	6.2	6.5	6.6	5.4
Group H	2.2	2.5	2.4	2.3	1.7	1.8	2.5	2.4	2.6	2.9	2.9	3.8
SEC/FTC	5.2	4.8	3.9	4.8	4.0	3.9	4.4	4.5	5.1	5.7	5.6	4.8

Fig. 4-2. Annual average return on sales for groups O, L, H, and the SEC/FTC durable goods firms.

Of consequence in this research is the trend of the return on sales ratio for firms in the defense market relative to the firms in the commercial market. Whether one group has a higher or lower index is interesting but not directly germane. The 1963-1967 years have been marked by no obvious increase or decrease in the return on sales figures for firms in Group H relative to the non-defense oriented firms. Thus, the incentive environment has had no apparent impact on the return on sales trend for defense and space firms.

Return on Assets

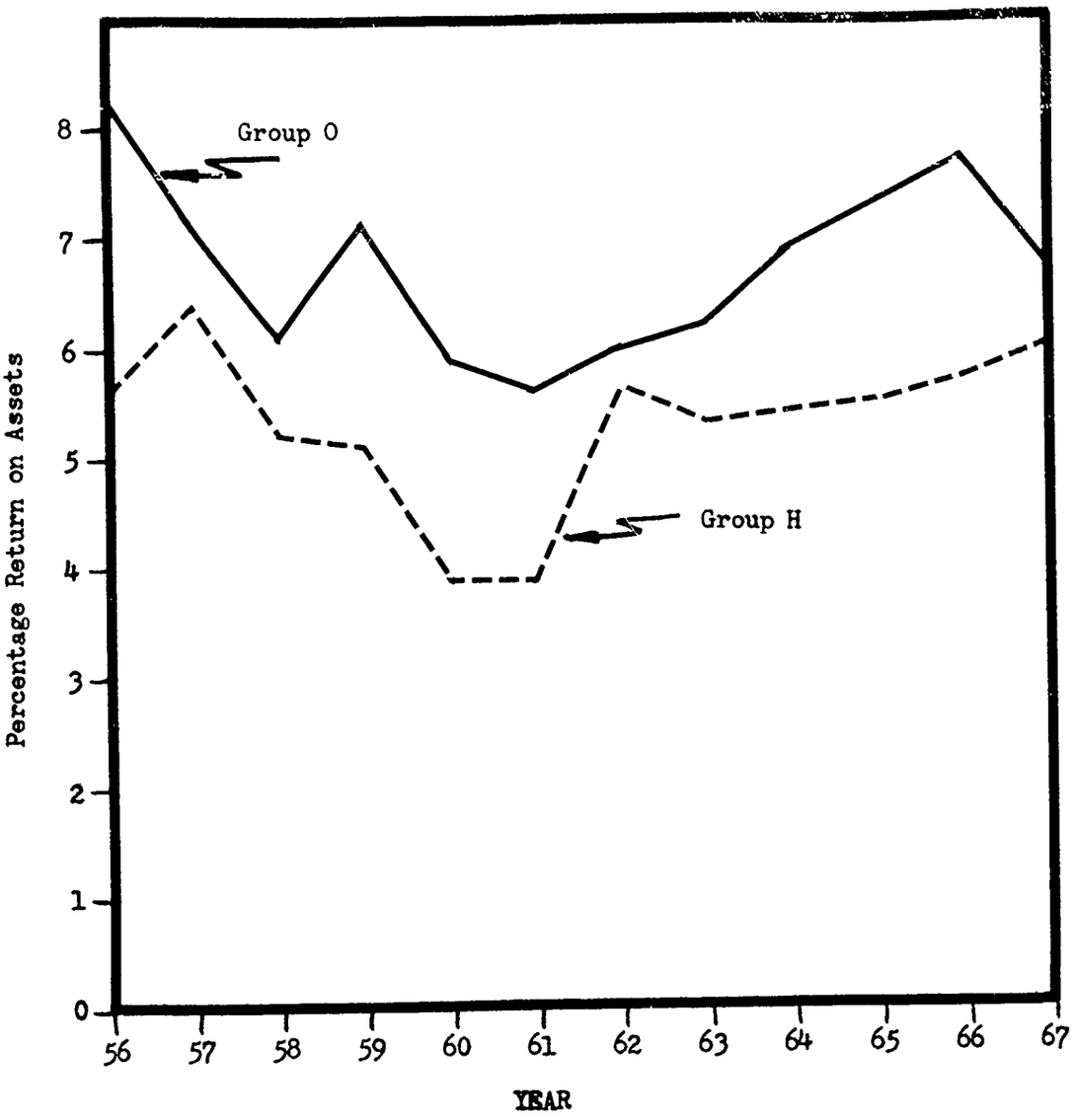
One measure of a firm's performance is its rate of return on the total assets employed. The return on assets, over time, provides a guide to determining a change in performance. As used in this research, return on assets is a net return--computed by dividing a firm's after tax profit by its total assets. For example, North American Rockwell's 1967 net income of $68.3 million and assets of 1.1 billion yield, a return on assets of nearly 6%. General Motors' 1967 net income of $1.6 billion and assets of $13.3 billion provide a return of over 12%.

Comparing the return on assets for different firms is not the intent of this section. What is of value is the comparison of trends between the different groups. The purpose of this comparison is to determine if the incentive environment has resulted in any relative change in the return on assets for firms dependent upon DOD and NASA for a large sales volume.

It is hypothesized that the increased use of incentives will result in a relative increase in the return on assets for firms in Group H. Figure 4-3 illustrates the trend for Groups H and O. Below the graph are tabulated the return on asset statistics for all groups including the SEC/FTC durable goods group described in the preceding section. The low point for Group H occurred in 1960-1961 and this is attributable to the previously discussed General Dynamics, Lockheed, and Douglas losses. In 1967 the average return on assets for Group H firms was 5.98%. The highest return in Group H was 11.37% while the next highest was 7.07%. The Group average without the high value reduces substantially to 5.56% which is in line with the average for preceding years. It is considered appropriate to discount the high value since it is attributable to a firm, new to the Fortune 500 in 1967, which has recently experienced a sharp cartridge and bomb case sales increase. These sales are obviously based upon Viet Nam generated demands and are not representative of incentive environment procurement.

Groups O and L in addition to the SEC/FTC group have very similar return on assets ratios and trends. The low percentage for all three of these groups occurred in the business recession of the early 1960's. Since 1961 the trend has been generally increasing.

A comparison of the return on assets trends for the various groups reveals nothing which would cause an acceptance of the hypothesis of this section. Discounting the 1967 statistics, it appears that the gap between return on assets for defense and non-defense oriented industrial firms is increasing rather than decreasing. Evidently the increased use of incentive contracts has not resulted in improved management of the



Group												
O	8.3%	7.1%	6.1%	7.1%	5.9%	5.6%	6.0%	6.2%	6.9%	7.3%	7.7%	6.7%
L	7.5	7.0	4.9	6.1	5.7	6.0	6.2	6.5	6.8	7.7	7.8	6.5
H	5.6	6.4	5.2	5.1	3.9	3.9	5.6	5.3	5.4	5.5	5.7	6.0
SEC/ FTC	7.6	6.9	5.1	6.5	5.4	5.0	5.9	6.2	7.0	7.9	7.8	6.4

Fig. 4-3. Annual average return on assets for groups O, L, H, and the SEC/FTC durable goods firms.

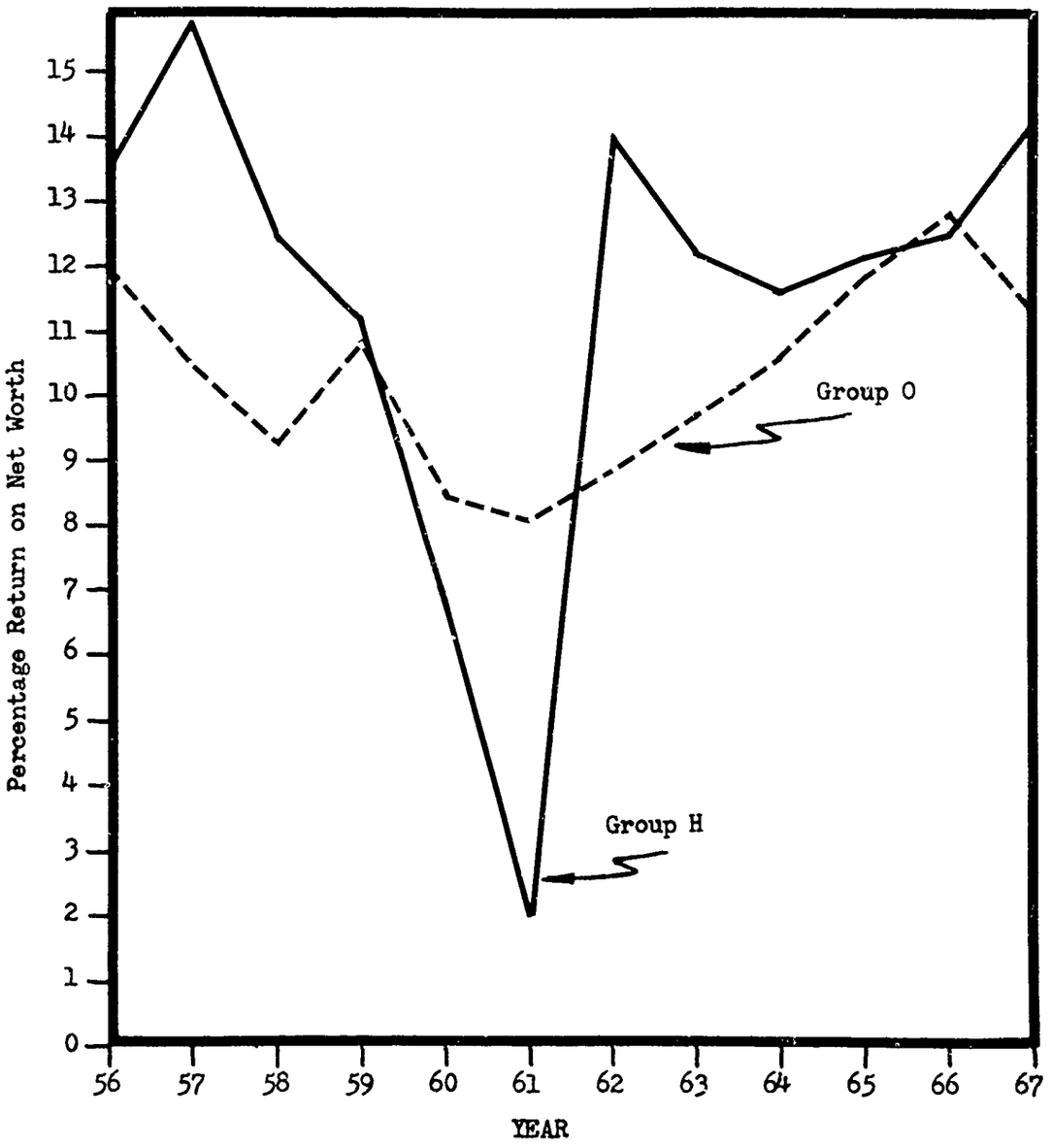
assets of firms obtaining over half of their sales revenues from DOD and NASA.

Return on Net Worth

An additional measure of a firm's performance is the trend of its rate of return on net worth. Net worth is defined as the sum of the capital stock, surplus, and retained earnings accounts and thus reflects the owners' investment. After tax return on net worth is obtained by dividing net income by net worth. The firms used in the examples of the preceding section, North American Rockwell and General Motors, in 1967 earned respective returns of 11.0% and 17.6%.

Figure 4-4 illustrates the return on net worth trends for firms in Groups O and H. Statistics for all groups are tabulated below the graph. Trends for Groups O, L, and the SEC/FTC durable goods manufacturers are very similar. The trends reflect the business recession of the early 1960's and a general improvement each year thereafter. What happened in 1967? Fortune answers that "A series of events suspiciously resembling the familiar cyclical correction of an overheated boom conspired to stem the long rise of corporate profits " (121:162)

What has been the relative trend between Groups H and O? In 1962 the average return on assets from firms in Group H was 14.0% while firms in Group O earned 8.9%--a difference of 5.1%. By 1966, Group O firms had increased their average return to 12.8% while Group H firms experienced an average return of 12.5%. Once again the 1967 ratio for Group H must be discounted due to the same firm which caused an excessively high return on assets average. Eliminating that one firm reduces the return on equity capital from 14.24% to 13.2%.



Group	%	%	%	%	%	%	%	%	%	%	%	%
O	12.0	10.5	9.3	10.8	8.5	8.1	8.9	9.7	10.6	11.8	12.8	11.3
L	13.6	12.4	7.2	10.3	9.4	9.9	10.4	10.8	11.6	13.5	14.3	12.5
H	13.4	15.7	12.5	11.2	6.7	2.0	14.0	12.2	11.6	12.2	12.5	14.2
SEC/ FTC	12.4	11.0	7.9	10.1	8.4	7.9	9.5	10.0	11.5	13.4	13.7	11.3

Fig. 4-4. Annual average return on net worth for groups O, L, H, and the SEC/FTC durable goods firms.

Since the time that DOD and NASA greatly increased their emphasis on motivating contractors by offering increased profit potential, the relative return on net worth for the major DOD and NASA contractors appears to have decreased. The industry-wide profit results of 1967 tend to obscure whatever trends exist. In any event, the trends certainly do not support acceptance of the hypothesis that increased profit incentives caused a corresponding relative increase in return on equity capital for defense oriented firms.

Capital Turnover

A common method of evaluating the efficiency of the use of a firm's capital is to examine its capital turnover. This ratio is computed by dividing sales by the capital resources of interest. Total capital (assets) and equity capital (net worth) are commonly used for this purpose.

The relationship of capital turnover and the previously discussed return on sales, assets, and net worth ratios is straightforward:

$$\text{Total Capital Turnover} = \frac{\text{Sales}}{\text{Assets}} = \frac{\text{Return on Assets}}{\text{Return on Sales}},$$

$$\text{Equity Capital Turnover} = \frac{\text{Sales}}{\text{Net Worth}} = \frac{\text{Return on Net Worth}}{\text{Return on Sales}}$$

Return on sales, assets, and net worth have been shown for all groups for the 1956 through 1967 period. Showing the turnover trends may be considered to be somewhat duplicative but it is of assistance in the analysis of the intergroup differences.

Total Capital Turnover

The average total capital turnover for Groups O and H are plotted

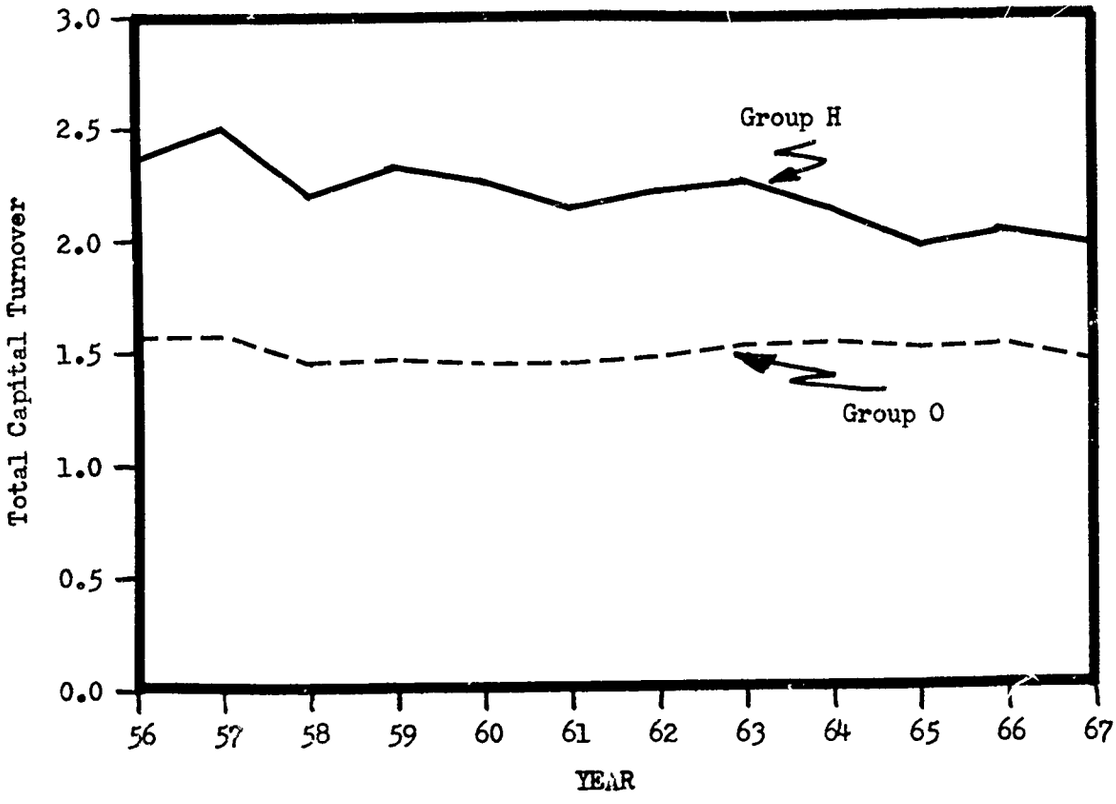
in Figure 4-5. Group O exhibits a nearly constant ratio of 1.5 throughout the twelve year period. Turnover for Group L has consistently remained slightly smaller than the Group O figure. The defense and space oriented firms long term turnover trend has been downward. This trend was not altered by the incentive environment. In 1956 the total capital turnover for Group H was 2.37. By 1962 it was 2.21 and by 1967 it had dropped to 1.98.

It is hypothesized that the average total capital turnover for Group H firms would exhibit a relative increase, or at least not a relative decrease, during the years defining the incentive environment. No evidence exists which would cause the hypothesis to be accepted. The trends truly support a rejection of the hypothesis.

Equity Capital Turnover

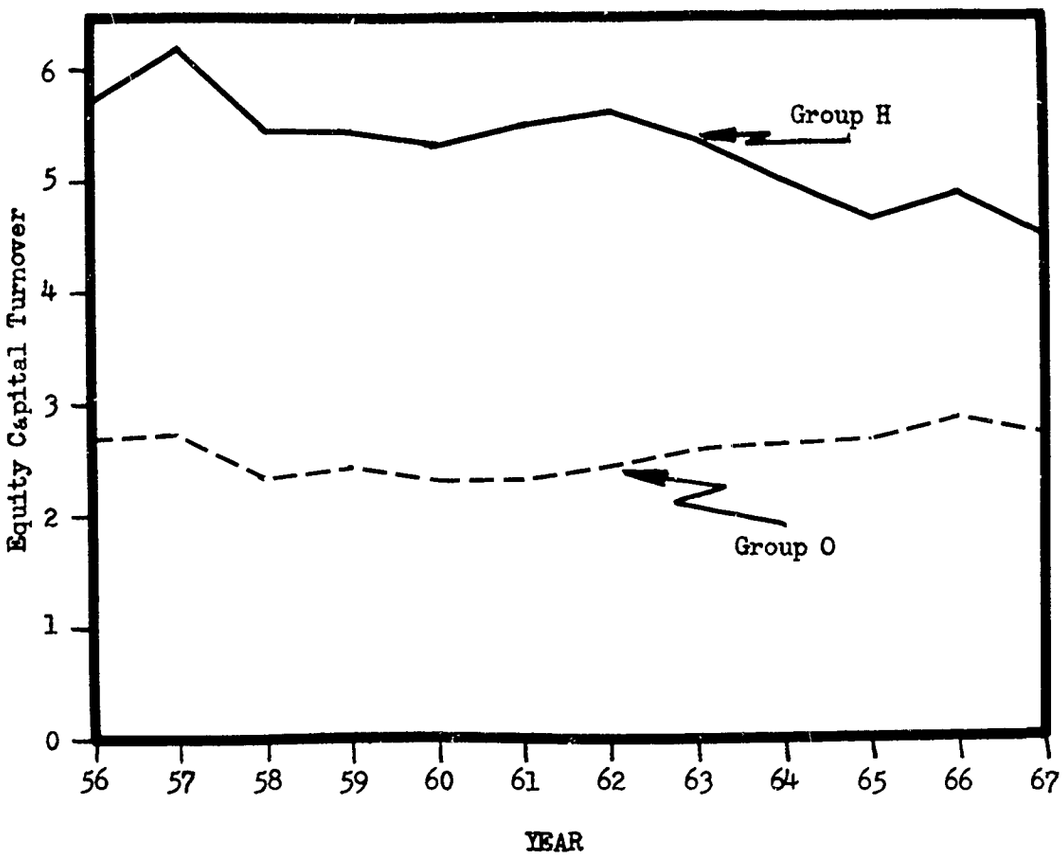
Equity capital turnover trends for Groups O and H are shown in Figure 4-6. The trends are very similar to the total capital turnover trends. Group O has not experienced a marked increase or decrease. It reached a low in the early 1960's and has gradually increased since that time. Group H firms evidence a substantially different trend. In 1956 the average equity capital turnover for Group H was 5.76. By 1967 it had decreased to 4.52. The decrease occurred over the entire period studied and showed no obvious shift during the incentive years.

Thus, it cannot be concluded that the incentive environment has increased the average relative equity capital turnover for the major defense and space contractors. It may even be concluded that the forces generated by the incentive environment were not even sufficient to dampen the already decreasing trend.



Group												
O	1.58	1.58	1.46	1.48	1.45	1.44	1.49	1.52	1.54	1.51	1.53	1.47
L	1.32	1.40	1.28	1.33	1.38	1.18	1.25	1.25	1.39	1.29	1.34	1.36
H	2.37	2.50	2.20	2.32	2.28	2.13	2.21	2.25	2.12	1.98	2.02	1.98

Fig. 4-5. Annual average total capital turnover for groups O, L, and H.



Group												
0	2.70	2.74	2.38	2.41	2.33	2.35	2.43	2.60	2.64	2.70	2.88	2.77
L	2.55	2.76	2.39	2.60	2.72	2.08	2.23	2.28	2.51	2.40	2.61	2.89
H	5.76	6.20	5.44	5.43	5.35	5.53	5.61	5.37	5.01	4.68	4.91	4.52

Fig. 4-6. Annual average equity capital turnover for groups O, L, and H.

Sales Dollars Per Employee

The trend of sales dollars per employee is a measure of a firm's management of its labor resources much as capital turnover trends measure a firm's management of its capital resources. It is hypothesized that increased profit incentives will result in increased attention to the management of the labor resources and thus yield additional sales dollars per employee.

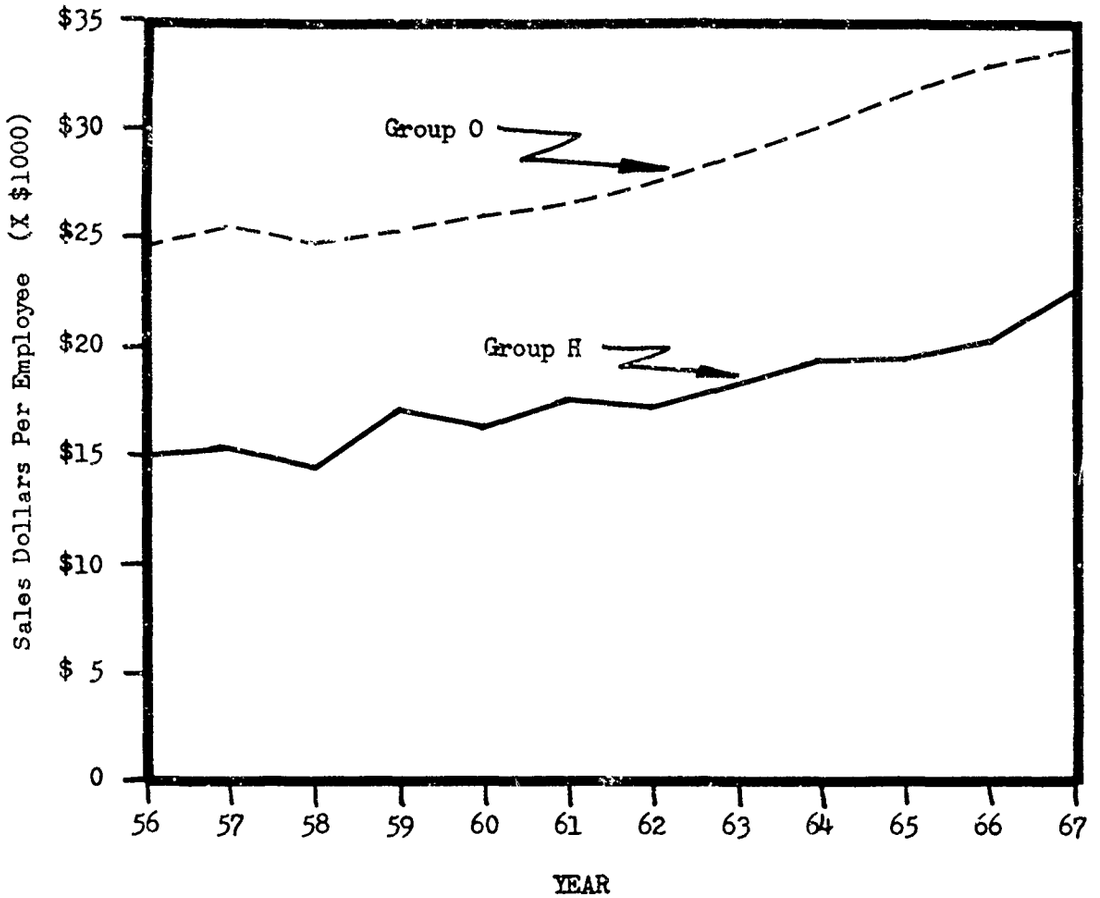
Figure 4-7 shows the sales dollars per employee trends for Groups O and H for the 1956-1967 period. Firms having essentially no direct defense and space business demonstrate a consistently increasing average number of sales dollars per employee. Their ratio of $24.69 per employee in 1956 climbed to $33.31 by 1967.

Group H firms have experienced a consistent growth in their average number of sales dollars per employee. Their trend parallels the Group O trend. The ratio grew from $14.95 to $22.69 per employee during the 1956-1967 period. The growth is remarkable but it cannot be attributed to the incentive period because the trend was not perturbed during the years of increased use of incentives in DOD and NASA contracts.

Based upon this evidence of no relative change in sales dollars per employee for the principal defense and space contractors, the hypothesis must be rejected. The incentive environment apparently did not, in general, cause increased efficiency in the use of labor resources.

Conclusions

Although the defense and space market involves thousands of business firms, it is concentrated on a relatively small number of large contractors. Most of these large contractors are included in the annual



Group												
O	24.7	25.5	24.9	25.3	26.1	26.8	27.5	28.9	30.1	31.8	33.0	33.8
L	22.5	23.3	25.1	24.8	23.7	25.9	26.9	29.0	29.3	24.8	27.3	26.9
H	15.0	15.2	14.5	17.1	16.4	17.7	17.3	18.2	19.3	19.4	20.2	22.7

Fig. 4-7. Annual average sales dollars per employee for groups O, L, and H.

Fortune 500. The other firms in the Fortune 500 provide a basis upon which the defense and space contractors' profitability trends can be measured. Annual average return on sales, return on assets, return on assets, return on net worth, total capital turnover, equity capital turnover, and sales dollars per employee ratios were computed for firms grouped on the basis of the percentage of sales revenue received from DOD and NASA for each of the years - 1956 through 1967.

If the incentive contracting environment is in fact motivating defense and space contractors toward increased efficiency in the employment of capital and labor resources, the result should be reflected in the firms' financial statistics. The hypothesis is that return on sales, return on assets, return on net worth, total capital turnover, equity capital turnover, and sales dollars per employee would increase for defense and space contractors relative to other similarly large firms and relative to their own previous trends.

Based upon the trends developed and analyzed in this chapter the hypothesis must be rejected. No relative increase in return on sales is detectable. Return on assets and return on net worth have not exhibited a relative increase. In fact, these ratios have apparently experienced a relative decrease during the incentive environment. Similarly, the turnover trends have not demonstrated a long term relative increase for the major defense and space contractors. Both total capital and equity capital turnover have decreased during the incentive environment years. Sales dollars per employee, although moving steadily upward, has not increased relative to the trends for commercially oriented firms. Thus, from a macroscopic analysis of the major defense and space firms it is

not possible to conclude that the significant shift to incentive and fixed-price contracts has resulted in increased efficiency in the use of capital and labor resources.

CHAPTER V

CONTRACT OUTCOMES - PART I

This chapter is the first of two chapters dedicated to analyzing the actual outcomes of a large sample of DOD contracts. The data sample used, its source, and a definition of terms are described. Specifically this chapter examines contract changes and overruns/underruns. Incentive theory states that the result of increasing a firm's incentive, i.e. profit potential, is increased underruns, or at least decreased overruns. This theory is evaluated with a series of hypothesis tests based on empirical data. Classical analysis of variance is the primary technique used for hypothesis testing.

In addition, this chapter considers the empirical results of contracts having incentive provisions in addition to cost incentives. A group of contracts with incentives for cost outcomes and schedule achievement is considered. A separate group of contracts with incentives for cost outcomes and performance levels is also considered.

Data Source and Definitions

Contract summaries were obtained from the Directorate for Statistical Services in the Office of the Secretary of Defense. The data was originally submitted to DOD by the Army, Navy, and Air Force procuring organizations on form DD 1500, "Record of Contract Completion", as required by the Armed Services Procurement Regulation.

The following is a listing of the "Record of Contract Completion" data elements used and explanatory information for each element:

Type of Contract: FPI, CPIF, or CPFF.

Type of Work: Production or research and development.

Department: Army, Navy, or Air Force.

Award Year: Fiscal year in which the contract was awarded.

Completion Year: Fiscal year in which the contract was completed.

Initial Cost: Originally negotiated cost (target).

Initial Profit: Originally negotiated profit (target).

Adjusted Cost: Initial cost plus the algebraic sum of all formal contract cost changes.

Adjusted Profit: Initial profit plus the algebraic sum of all formal contract profit changes.

Final Cost: Actual cost of the work.

Final Profit: Actual profit for the work.

Sample Description

To be included in the sample used in this research a contract had to meet a variety of constraints. These constraints include such variables as year of award, year of completion, type of contract, and size of contract.

Although the contract summary data maintained by DOD dates back to fiscal year 1959, the contracts selected for this research were limited to those awarded not earlier than fiscal year 1963 and completed by the end of fiscal year 1968. This period is consistent with the previously defined incentive environment. Table 5-1 shows the number of contracts in the sample which were awarded and completed in each of the fiscal years 1963 through 1968.

TABLE 5-1

CONTRACT SAMPLE BY YEAR OF AWARD AND YEAR OF COMPLETION

Fiscal Year	Number of Contracts	
	Awarded	Completed
1963	347	12
1964	255	77
1965	124	104
1966	85	137
1967	22	260
1968	1	244
Total	834	834

The contracts were limited to the FPI, CPIF, and CPFF types. With the exception of the firm-fixed-price type these are the pricing arrangements most frequently used. No complete contract summary data is available for the firm-fixed-price type of contract. Of the 834 contracts in the sample, there are 195 CPIF, and 474 CPFF. Table 5-2 provides this and other general classifications of the sample.

The sample contains 275 Army, 129 Navy, and 430 Air Force contracts. Dividing the sample by the type of work yields 370 production and 464 research and development contracts.

The sample was limited to contracts having an initial price (cost plus profit) or final price over $200,000. The distribution of contracts by price is shown in Table 5-3. Nearly half of the contracts in the sample have a final price over one million dollars. The combined final price of the 834 contracts is well over four billion dollars.

TABLE 5-2

CONTRACT SAMPLE BY TYPE OF CONTRACT, WORK, AND SERVICE

Variable	Subdivision	Number of Contracts
Type of Contract	FPI	195
	CPIF	165
	CPFF	474
Type of Work	Production	370
	R & D	464
Department	Army	275
	Navy	129
	Air Force	430
Total		834

TABLE 5-3

CONTRACT SAMPLE BY INITIAL, ADJUSTED, AND FINAL PRICE

Price ($ in thousands)	Number of Contracts		
	Initial Price	Adjusted Price	Final Price
< $200	100	17	2
$200≤ < 400	181	215	229
400≤ < 600	114	118	120
600≤ < 800	65	65	63
800≤ < 1,000	34	45	46
1,000≤ < 5,000	228	247	244
5,000≤ < 10,000	49	55	56
10,000≤ < 25,000	38	36	40
25,000≤ < 50,000	14	19	17
50,000≤ <100,000	9	13	12
100,000≤	2	4	5
Total	834	834	834
Total Dollars	$3.4 billion	$4.3 billion	$4.3 billion

Contract Growth Defined

As used in this research the term contract growth refers to two separate elements. The first of these elements, change, is expressed as a percentage of the initial cost. It includes all contract modifications, changes, supplemental agreements, etc. and is defined as:

$$(1) \qquad \text{Change } \% = \frac{Ca - Ci}{Ci} \times 100,$$

where Ca = adjusted contract cost; and

Ci = initial contract cost.

The second element, overrun/underrun, is expressed as a percentage of the adjusted cost. If negative, it is an underrun. It is defined as:

$$(2) \qquad \text{Overrun } \% = \frac{Cf - Ca}{Ca} \times 100,$$

where Cf = final contract cost.

Change and Overrun/Underrun for Three Types of Contracts

The average change for the 834 contracts is 58.1% while the average overrun is only 1.8%. Change and overrun data for the different types of contracts is shown in Table 5-4. The largest average change, 76.8%, is for CPFF contracts. FPI contracts have a 21.2% average increase in the initial cost target. The difference in average overrun between contract types is much smaller. CPFF contracts have an average overrun of

2.0% while CPIF and FPI overrun averages are 1.4% and 1.5%, respectively. The distribution of overruns for each type of contract is illustrated in Figure 5-1. It is interesting to note that 62.9% of the 834 contracts have a final cost within $\pm$ 5% of their respective adjusted costs. The percentage varies considerably between contract types. For example, 75.4% of the CPFF contracts have outcomes in this range compared to only 36.4% of the FPI contracts. The outcomes are nearly evenly divided between overrun and underrun conditions.

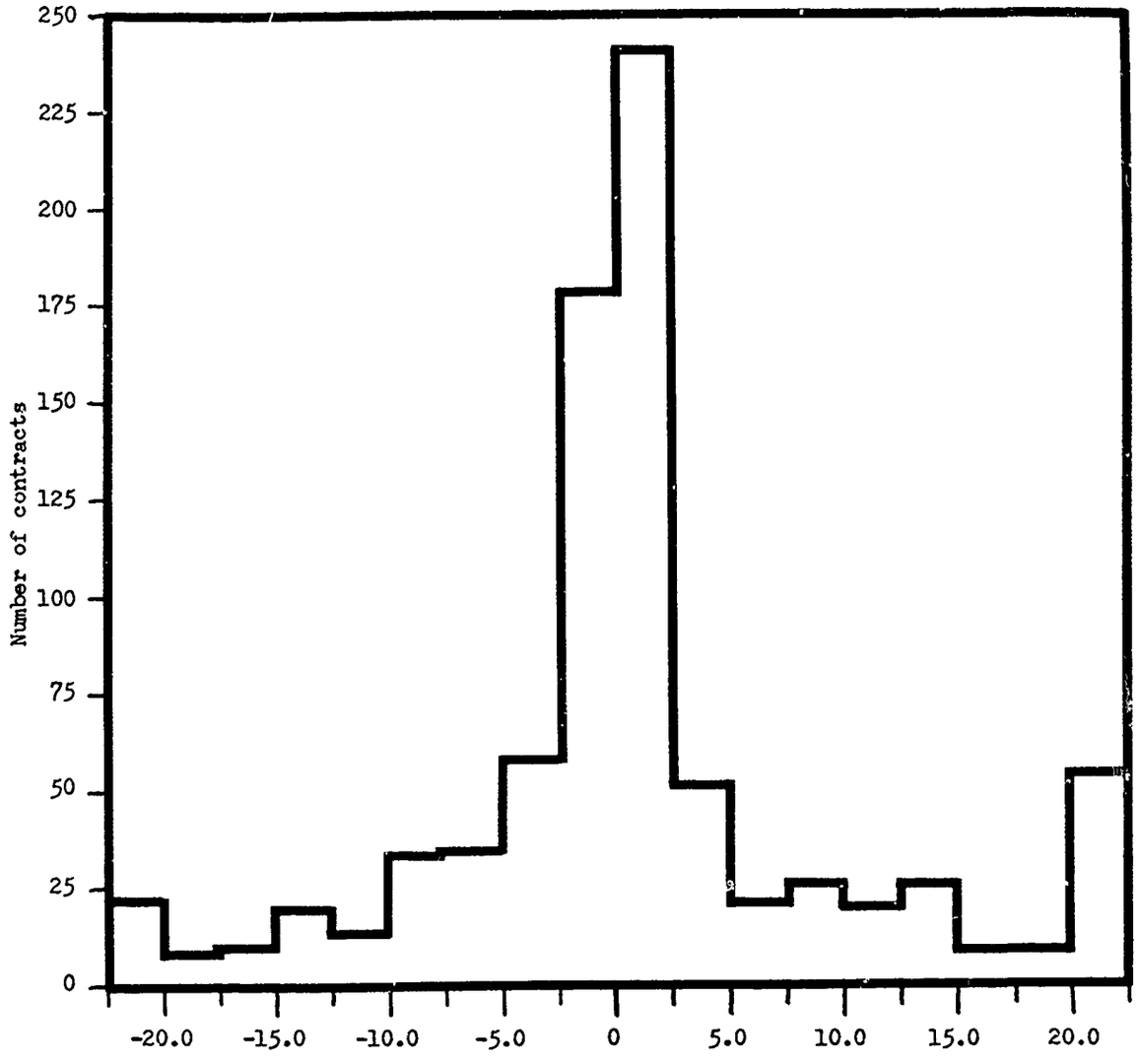
TABLE 5-4

AVERAGE CONTRACT CHANGE AND OVERRUN BY TYPE OF CONTRACT

Type of Contract	Number	Mean Change	Mean Overrun
FPI	195	21.2%	1.5%
CPIF	165	48.3	1.4
CPFF	474	76.8	2.0
Total	834	58.1	1.8%

Change and Overrun/Underrun for Two Types of Work

The two general classes of work are production and research and development. Change and overrun data for each of these classes of work is shown in Table 5-5. The average change for the 370 production contracts is 54.6% while the 464 research contracts exhibit an average change of 60.9%. The difference in average change appears to be less between the types of work than between the different types of contracts. Conversely, the difference between the average production contract overrun of 0.2% and the average research contract overrun of 3.0% is larger than the differences between the types of contracts.



FPI	6	3	5	9	4	17	9	19	17	22	18	9	15	8	17	2	3	12
CPIF	8	3	1	5	7	9	5	9	44	30	8	8	3	3	3	4	2	13
CPFF	8	2	4	6	3	8	21	30	118	189	20	5	8	9	6	3	4	30

Fig. 5-1. Distribution of overruns for FPI, CPIF, and CPFF contracts.

TABLE 5-5

AVERAGE CONTRACT CHANGE AND OVERRUN BY TYPE OF WORK

Type of Work	Number	Mean Change	Mean Overrun
Production	370	54.6%	0.2%
R & D	464	60.9	3.0
Total	834	58.1	1.8

Relationship of Contract Change and Overrun/Underrun

One possible way of reducing potential overruns (or increasing potential underruns) is to increase the target cost of the contract by means of contract changes. One approach to examining the extent of this misuse of contract change is to determine the relationship of contract change percentage and overrun/underrun percentage as follows:

$$\text{Overrun \%} = a + b(\text{Change \%}) \quad (3)$$

where a and b are unknown regression coefficients.

This relationship was first tested for the entire group of 834 contracts. The results suggested further research. The group of contracts was then divided, by type of contract, into three subgroups for which regression coefficients were estimated. Similar calculations were made for research contracts and production contracts. Results of these six tests are contained in Table 5-6.

In none of the tests of Equation 3 is the estimated value of the coefficient b compared to its standard error such that it commands a high

degree of confidence. Thus there is no close relationship between the percentage of contract change and the overrun/underrun outcome.

TABLE 5-6

REGRESSION COEFFICIENTS FOR SIX TESTS WITH OVERRUN/UNDERRUN PERCENTAGE AS THE DEPENDENT VARIABLE AND CHANGE PERCENTAGE AS THE INDEPENDENT VARIABLE

Contract Group	a	b	Standard Error of b	Null Hypothesis Rejection Level
834 FPI, CPIF, & CPFF	2.0087	-0.0039	0.0023	0.09
195 FPI	1.5211	-0.0001	0.0109	> 0.50
165 CPIF	1.7719	-0.0080	0.0066	0.23
474 CPFF	2.2906	-0.0034	0.0025	0.18
370 Production	0.4692	-0.0048	0.0035	0.18
464 R & D	3.2369	-0.0032	0.0029	0.32

Analysis of Variance of Contract Change

The average percentage change from the initial cost target to the adjusted cost target appears to vary substantially for contracts grouped by pricing arrangement and also for contracts grouped by type of work. The important question at this point is, are the differences significant?

A two-way analysis of variance was applied to test the null hypotheses that, at the 1% level of significance, the mean changes are equal for the three types of contracts and also that the mean changes are equal for the two types of work. The two-way analysis was used to eliminate the possible confounding of results. For example, the average percentage change for FPI contracts should be independent of the change differential due to the type of work. Similarly, the average percentage change for, say, research and development contracts should be independent of the change

attributable to the type of contract pricing arrangement. The unequal cell size model suggested by Snedecor was used for this and the other analyses of variance in this research. (16:484-488)

A complete summary of this analysis of variance is contained in Table 5-7. Note in Table 5-7b that the average change percentages for the three types of contracts are significantly different at the 1% level. The average change percentages for the two types of work are not statistically different at the 1% level of significance. The salient indicator of contract change as a percentage of initial cost is, therefore, the type of contract. This is not intuitively objectionable since the key to the selection of the proper type of contract is the uncertainty of various issues of the procurement. These uncertainties were discussed in Chapter II.

It is interesting to note the adjustments shown in Table 5-7c. The adjusted average difference in contract change due to the type of work is 12.4%, i.e. the average production contract change percentage is 12.4% greater than the average change percentage for research and development contracts. Although this adjusted difference appears large, it is not considered significant due to the large variances. The adjusted averages of 24.1%, 48.4%, and 74.3% for FPI, CPIF, and CPFF contracts, respectively, are very similar to the unadjusted averages shown in Table 5-4.

Analysis of Variance of Contract Overrun/Underrun

Are the average cost overrun percentages different for the three types of contracts studied? Are the average cost overrun percentages different for production and research types of work? Are the differences

TABLE 5-7

ANALYSIS OF VARIANCE OF CONTRACT CHANGE
FOR 834 FPI, CPIF, AND CPFF CONTRACTS

5-7a. Number and Mean Percentage Change

Type of Contract	Production		R&D	
	Number	Mean	Number	Mean
FPI	144	25.3%	51	9.6%
CPIF	84	70.2	81	25.5
CPFF	142	75.2	332	77.5

5-7b. Adjusted Analysis of Variance

Source of Variation	d.o.f.	Sums of Squares	Mean Square
Work	1	27249.27	27249.27
Contract	2	466572.72	233286.36**
Interaction	2	64955.73	32477.86
Within	828		45350.28

** Null hypothesis rejected at the 1% level of significance.

5-7c. Adjustments

Adjusted difference in mean change due to type of work: 12.4%

	FPI	CPIF	CPFF
Adjusted contract means:	24.1%	48.4%	74.3%

significant? The apparently similar average overrun percentages shown in Tables 5-4 and 5-5 are inconclusive due to the confounding of the type of contract and type of work effects.

A two-way analysis of variance was applied to test for equality of means between types of contracts and between types of work. Table 5-8 summarizes this analysis of variance. The null hypothesis for types of contracts was not rejected at the 1% level of significance. On the other hand, the null hypothesis for types of work was rejected at the 1% level. Thus, the fundamental indicator of overrun as a percentage of adjusted cost is not the type of contract pricing arrangement but rather the type of work.

Although both production and research contracts have average overruns, the research contracts average percentage is 3.1% higher than the productions contracts. This adjusted difference is shown in Table 5-8c. Also in this table are the adjusted average overrun percentages for the three types of contracts: FPI 0.8%, CPIF 1.3%, and CPFF 2.7%.

Change and Overrun/Underrun for Incentive Contracts

In this section the average contract change and overrun percentages are examined for a sample of incentive contracts. The sample of 159 FPI and 105 CPIF contracts is divided into three groups based upon the size of the contractor's portion of the share ratio. The limits used for the three groups are: 15% or less, more than 15% but not more than 30%, and more than 30%.

Unfortunately the share ratio is not specified on the DOD "Record of Contract Completion". Therefore, for each of these incentive contracts the contractor's share, α, is constructed from other data as follows:

TABLE 5-8

ANALYSIS OF VARIANCE OF CONTRACT OVERRUN/UNDERRUN
FOR 834 FPI, CPIF, AND CPFF CONTRACTS

5-8a. Number and Mean Percentage Overrun/Underrun

Type of Contract	Production		R&D	
	Number	Mean	Number	Mean
FPI	144	0.9%	51	3.4%
CPIF	84	-2.7	81	5.6
CPFF	142	1.3	332	2.4

5.8b. Adjusted Analysis of Variance

Source of Variation	d.o.f.	Sums of Squares	Mean Square
Work	1	1666.47	1666.47**
Contract	2	91.36	45.68
Interaction	2	1530.03	765.01
Within	828		190.84

**Null hypothesis rejected at the 1% level of significance.

5-8c. Adjustments

Adjusted difference due to type of work:			-3.1%
	FPI	CPIF	CPFF
Adjusted contract means:	0.8%	1.3%	2.7%

$$\alpha = \frac{Pf - Pa}{Ca - Cf} \times 100,$$

where Pf = final contract profit;

Pa = adjusted contract profit;

Ca = adjusted contract cost; and

Cf = final contract cost.

The results of constructing the sharing percentages and grouping is shown in Table 5-9.

TABLE 5-9

AVERAGE AND STANDARD DEVIATION OF SHARING PERCENTAGE FOR EACH OF THREE GROUPS OF INCENTIVE CONTRACTS

Sharing Limits	Number of Contracts	Average Share	Standard Deviation
$\alpha \leq 15\%$	106	9.9%	3.3%
$15\% < \alpha \leq 30\%$	100	22.2	4.6
$30\% < \alpha$	58	39.2	7.6
Total	264	21.0	12.2

In the group of contracts with the contractor's share less than or equal to 15% there are 106 contracts whose average share is 9.9%. The group of contracts with large contractor shares includes 58 contracts whose average share is 39.2%.

For each of these three groups of incentive contracts the average percentage change and the average percentage overrun/underrun are calculated. The results are delineated in Table 5-10. The average change from initial target cost to adjusted target cost for these 264 incentive

contracts is 38.7%. The group having the highest average change, 48.9%, is composed of contracts with the contractor's share in the 15% to 30% range. Those contracts with a contractor's share of 15% or less have an average change of 27%. Are the average changes for the three groups significantly different? To answer this question an analysis of variance was made.

A two-way analysis was used with the three groups of share ratios and the two types of work as the factors. Results of the analysis of variance are shown in Table 5-11. The mean change of the production contracts is significantly different, at the 1% level, than the mean of the research contracts. The adjusted difference reveals that production contracts in this sample have an average change percentage 17.1% higher than research contracts. The mean change percentages for the three different α groups are also significantly different at the 1% level. The adjusted averages for the two groups with a high α, over 15%, are 52.0% and 46.9%, respectively. The low α group's adjusted mean of 29.1% is quite different.

TABLE 5-10

AVERAGE CHANGE AND OVERRUN/UNDERRUN FOR EACH OF THREE GROUPS OF INCENTIVE CONTRACTS

Sharing Limits	Average Change	Average Overrun/Underrun
$\alpha \leq 15\%$	27.0%	1.7%
$15\% < \alpha \leq 30\%$	48.9	- 1.3
$30\% < \alpha$	42.2	0.7
Total	38.7	0.4

TABLE 5-11

ANALYSIS OF VARIANCE OF CONTRACT CHANGE
FOR 264 INCENTIVE CONTRACTS

5-11a. Number and Mean Percentage Change

Contractor's Sharing Percentage	Production		R&D	
	Number	Mean	Number	Mean
$\alpha \leq 15\%$	66	23.7%	40	32.5%
$15\% < \alpha \leq 30\%$	68	60.2	32	25.0
$30\% < \alpha$	45	51.6	13	9.5

5-11b. Adjusted Analysis of Variance

Source of Variation	d.o.f.	Sums of Squares	Mean Square
Work	1	236781.25	236781.25**
Share Ratio	2	253848.06	126924.00**
Interaction	2	30141.24	15070.62
Within	258		897C.36

** Null hypothesis rejected at the 1% level of significance.

5-11c. Adjustments

Adjusted difference due to type of work: 17.1%

Adjusted α group means:	$\alpha \leq 15\%$	$15\% < \alpha \leq 30\%$	$30\% < \alpha$
	29.1%	52.0%	46.9%

Thus, both the type of work and the size of the contractor's share are significant indicators of the percentage change of an incentive contract's initial cost.

The average overrun/underrun percentages shown in Table 5-10 appear to be unequal. To test for equality and to eliminate confounding, a two-way analysis of variance was applied. The two factors are type of work and the size of the contractor's portion of the share ratio. Table 5-12 presents a complete summary of this analysis. As in the previous analysis of variance, the null hypothesis was rejected, at the 1% level, for both factors. Production contracts exhibit an average underrun while research contracts overrun. The difference in percentage attributed to the type of work is 8.1%. The adjusted averages for the three α levels are shown in Table 5-12c. It is important to note that contracts having a small α tend to overrun while contracts with a higher α tend to underrun.

Regression of Sharing Rates, Overrun/Underrun, and Change

The significant difference in average overrun percentages for groups of contracts with different incentive shares suggests the existence of some correlation between the size of the contractor's sharing percentage and the percentage of cost overrun. Linear regression analysis was used to investigate the relationship defined by:

$$\text{Overrun \%} = a + b\alpha \quad , \tag{5}$$

where α = contractor's sharing percentage; and

a and b are undetermined coefficients.

TABLE 5-12

ANALYSIS OF VARIANCE OF CONTRACT OVERRUN/UNDERRUN
FOR 264 INCENTIVE CONTRACTS

5-12a. Number and Mean Percentage Overrun/Underrun

Contractor's Sharing Percentage	Production		R&D	
	Number	Mean	Number	Mean
$\alpha \leq 15\%$	66	-2.7%	40	9.0%
$15\% < \alpha \leq 30\%$	68	-2.8%	32	1.9%
$30\% < \alpha$	45	-0.9%	13	6.1%

5-12b. Adjusted Analysis of Variance

Source of Variation	d.o.f.	Sums of Squares	Mean Square
Work	1	4008.52	4008.52**
Share Ratio	2	3291.64	1645.82**
Interaction	2	606.97	303.49
Within	258		71.05

** Null hypothesis rejected at the 1% level of significance.

5-12c. Adjustments

Adjusted difference due to type of work: -8.1%

Adjusted α group means:	$\alpha \leq 15\%$	$15\% < \alpha \leq 30\%$	$30\% < \alpha$
	0.7%	-2.8%	-1.6%

The theory is that large contractor sharing percentages will motivate the contractor to underrun or at the least decrease overruns. Thus, the expected sense of the coefficient b is negative.

Eight regression tests were performed. The incentive contracts included in each test were grouped in order to determine if differences exist between FPI and CPIF contracts, production and research contracts, as well as between contracts with different contractor sharing percentages. The results of these tests are summarized in Table 5-13. In four of the tests the estimated value of b is negative, indicating that for these contract groups an increase in sharing, α, corresponds to a decrease in overrun. It is surprising that three of the positive estimates of b are for contract groups with high values of α. All eight estimates of b were tested for statistical significance. In no case was the null hypothesis rejected at the 1% level. It should be noted here that inference based upon the estimate of b is equivalent to inference based upon the significance of the correlation coefficient. (16:184)

The significant difference in average contract change for the three groups of incentive contracts suggests the existence of some correlation between the size of the change percentage and the contractor's sharing rate. Fisher suggests that, "Contractors may request changes more frequently for contracts with large sharing rate values in order to compensate for the increased financial risk." (68:30) Linear regression analysis was used to investigate this relationship:

$$\text{Change \%} = a + b\alpha \quad , \tag{6}$$

TABLE 5-13

REGRESSION COEFFICIENTS FOR EIGHT TESTS WITH OVERRUN/UNDERRUN PERCENTAGE AS THE DEPENDENT VARIABLE AND CONTRACTOR'S SHARE RATIO AS THE INDEPENDENT VARIABLE

Contract Group	a	b	Standard Error of b	Null Hypothesis Rejection Level
264 FPI & CPIF	1.104	-0.036	0.079	> 0.50
179 Production	-3.705	0.064	0.074	0.40
85 R & D	8.091	-0.119	0.187	> 0.50
159 RPI	-2.214	0.080	0.075	0.30
105 CPIF	5.787	-0.321	0.234	0.18
106 $\alpha \leq 15\%$	11.664	-1.007	0.574	0.09
158 $\alpha > 15\%$	-4.942	0.154	0.093	0.10
58 $\alpha > 30\%$	-13.137	0.353	0.230	0.13

where α = contractor's sharing percentage; and

a and b are undetermined coefficients.

Regression tests were again performed on the previous eight groups of incentive contracts to determine if differences existed between contract types and between different values of α. The results of these eight tests are shown in Table 5-14. In no case was the null hypothesis rejected at the 1% level. The group of 159 FPI contracts, with an estimated value of b significant at the 2% level, provides an interesting case. For this group a 10% increase in sharing corresponds to an increase in change of nearly 15%. The meaning of this statistically significant relationship is not clear. The primary reason for the lack of clarity is the weakness of the relationships in the other contract groups.

TABLE 5-14

REGRESSION COEFFICIENTS FOR EIGHT TESTS WITH CHANGE PERCENTAGE AS THE DEPENDENT VARIABLE AND CONTRACTOR'S SHARE RATIO AS THE INDEPENDENT VARIABLE

Contract Group	a	b	Standard Error of b	Null Hypothesis Rejection Level
264 FPI & CPIF	26.361	0.587	0.856	0.50
179 Production	22.221	1.011	1.236	0.20
85 R & D	38.510	-0.668	0.528	0.40
159 FPI	-12.172	1.462	0.587	0.02
105 CPIF	36.293	1.619	2.831	> 0.50
106 $\alpha \leq 15\%$	38.918	-1.201	1.867	> 0.50
158 $\alpha > 15\%$	43.865	0.091	1.679	> 0.50
58 $\alpha > 30\%$	-114.493	4.000	2.402	0.10

Multiple Incentive Contract Outcomes

The incentive contracting literature contains many cautions regarding the importance of having multiple incentives finely balanced within a contract. Once again, the theory is that contractors will maximize their profit dollars on a contract regardless of how they have to "trade" potential profits on the cost dimension for, say, potential profits on the schedule dimension. Some analysts conclude that these trade-offs are largely theoretical in nature and are subordinate to stronger operational pressures. For example, Jones concludes that, "Program pressures outside the contract are stronger than contractual incentives and overall program success is the overriding consideration which tends to swamp decisions indicated by trade-off analysis." (43:8)

Some evidence is available regarding the outcomes of contracts with incentives on the cost outcome as well as incentives on schedule and/or performance. Of the 264 incentive contracts discussed in the previous sections, 42 have multiple incentives. The DOD contract summary data discloses contracts in which performance or schedule incentives are earned or lost but does not permit inference regarding multiple incentive contracts in which the performance or schedule incentives fail to add or detract from contract profit.

An examination of those contracts in which performance incentives have been earned or lost reveals two strong tendencies. First, performance incentives are earned more frequently than lost. Of the contracts in this sample, 76.5% earned at least a portion of the performance incentive. Second, performance incentives are earned regardless of the cost outcomes. Of the contracts earning performance incentives, 34.6% earned cost incentives, 38.5% lost cost incentives, and the remaining 27% neither overran or underran their target costs. These relationships are based on the data shown in Table 5-15.

TABLE 5-15

OUTCOMES ON CONTRACTS HAVING COST AND PERFORMANCE INCENTIVES

Cost Outcomes	Performance Incentives	
	Earned	Lost
Underrun	9	1
On Target	7	4
Overrun	10	3
Total	26	8

The inferences regarding the relationships of outcomes between cost incentives and schedule incentives are interesting but not strong due to the limited number of contracts in this sample. Of the twelve contracts, eight received schedule penalties. Seven of these eight contracts also experienced cost overruns. Thus, bearing in mind the sample size, there appears to be a tendency for schedule incentives to be lost more frequently than earned and also a tendency for late deliveries to be positively correlated with cost overruns.

Comparison of Results With Other Research

Contract changes and overruns have been examined by Fisher (68) and Jones. (144) The results of their work are now compared with the results contained in this chapter.

The 948 FPI, CPIF, and CPFF contracts included in Fisher's study were completed during fiscal years 1960 through 1966. Jones' sample group A of 345 FPI, CPIF, and CPFF contracts was comprised of contracts completed during calendar years 1963 through 1965. His group B included 44 FPI, CPIF, and CPFF contracts with five contractors. Both Fisher and Jones consider only Air Force contracts. Jones computes change and overruns as they are defined in this research. Unfortunately, for the sake of comparison, Fisher uses slightly different definitions:

$$(7) \qquad \text{Change } \% = \frac{Ca - Ci}{Ci} \times 100, \text{ and}$$

$$(8) \qquad \text{Overrun } \% = \frac{Cf - Ca}{Cf} \times 100,$$

where: Ca = adjusted contract cost;

Ci = initial contract cost; and

Cf = final contract cost.

The average change percentage and overrun/underrun percentage as found by Fisher and Jones for each contract type are shown in Table 5-16. Due to the difference in definition, Fisher's averages must be positively increased before being compared with the other results. Unfortunately, it is not possible to convert from one definition to the other without the original data.

The relationship between the sharing percentage and contract growth was also examined for types of incentive contracts by Fisher.

TABLE 5-16

CHANGE AND OVERRUN FOR FPI, CPIF, AND CPFF CONTRACTS AS FOUND BY FISHER, JONES, AND BELDEN

Type of Contract	Fisher[a]	Jones A[b]	Jones B[b]	Belden[c]
		Change		
FPI	4.17%	13.7%	18.5%	24.1%
CPIF	77.15	51.8	34.1	48.4
CPFF	60.08	314.6	68.4	74.3
		Overrun/Underrun		
FPI	-3.18%	-1.9%	-1.3%	0.8%
CPIF	1.29	5.3	6.2	1.3
CPFF	1.90	0.1	0.6	2.7

a. (68:21, 29).
b. (144:59, 67).
c. Tables 5-6 and 5-7.

He conclucluded that "overruns/underruns seem to be unrelated to the value of the incentive sharing rate". (68:27) He similarly concluded that contract change was "not closely related" to the sharing percentage. Thus, the results of the series of regressions discussed in this chapter are consistent with the previous analysis which considered contracts grouped by type of pricing arrangement but did not consider those contracts grouped by the size of the sharing percentage.

Two interesting differences exist between earlier results and the findings in this chapter. First, the average contract change percentage has substantially increased for FPI contracts and decreased for both CPIF and CPFF's. Secondly, overrun has replaced underrun as the sense of the FPI contract outcome. This change appears to be the critical difference which permitted Fisher to reject the null hypothesis of equality of overrun/underrun means at the 1% level of significance while the same hypothesis for the current sample could not be similarly rejected.

The primary difference in the Fisher, Jones, and present groups of contracts is time. Apparently, the procurement environment of the mid-1960's is producing contract growth outcomes measurably different from the results of the late 1950's and early 1960's.

Conclusions

The following conclusions are primarily based upon the results of the analyses of variance and regressions used to investigate the contract change and overrun/underrun outcomes of the DOD contract sample;

1. It was not possible to conclude that target costs were increased in order to reduce potential overruns or increase potential

underruns. No close relationship between the percentage of contract change and the overrun/underrun outcome was found.

2. The significant indicator of the size of contract overruns/underruns is the type of work and not the type of contract. The opposite is true for contract change. These outcomes suggest that some lack of consistency existed when decisions were being made regarding the type of contract to use for the various procurements represented by the 834 contracts studied.

3. The relationship between the size of the contractor's sharing percentage and the change in target cost is not clear. For most of the tests conducted, no meaningful relationship could be found. However, for the group of 159 FPI contracts and, to a lesser degree, the 58 FPI and CPIF contracts with large share ratios evidenced a direct relationship between the percentage change in the target cost and the size of the share.

4. The overrun/underrun contract outcome is independent of the size of the sharing ratio. Large contractor sharing percentages have not resulted in decreased overruns or increased underruns.

5. A strong tendency exists for performance incentives to be at least partially earned. This tendency holds regardless of the cost overrun or underrun outcome. Schedule incentives tend to be at least partially lost rather than earned. Also, a tendency exists for late deliveries and cost overruns to occur together. These comments regarding schedule incentives are at best weak due to the extremely small sample size examined.

6. A comparison of the results of the recent, 1963-1968, contract outcomes with the results of previous research provides some interesting trends. Recent FPI contracts have a higher average change percentage while CPIF and CPFF contracts exhibit a lower average change percentage than indicated by results of earlier research. Also, recent FPI contracts evidence an average overrun while earlier FPI contracts have had an average underrun.

CHAPTER VI

CONTRACT OUTCOMES - PART II

This chapter examines an additional contract outcome dimension--profit. The actual profit earned, referred to as coming out profit, is a function of several other variables. These variables include the target (going in) profit, sharing ratio, and overrun/underrun. Thus, the examination of coming out profits in relation to the other variables provides an additional view of the results of the incentive environment.

Specifically, this chapter compares the distribution of going in profits for different types of contracts. It examines the statistical significance of the differences attributable to the type of contract pricing arrangement and the type of work for going in and coming out profits. The relationship of the contractor's sharing percentage and profit is also examined. Analysis of variance and regression are the principal testing procedures employed.

Profit Definitions

Profit on DOD and NASA contracts is normally referred to as a percentage--profit dollars as a percentage of cost dollars. Profit dollars, in the simple cost incentive case, are determined as follows:

$$Pf = Pa + \alpha(Ca - Cf) \quad (9)$$

where Pf = coming out profit dollars;

Pa = going in profit dollars (adjusted);

α = contractor's sharing percentage;

Ca = adjusted contract cost; and

Cf = actual contract cost.

Going In and Coming Out Profits for Three Types of Contracts

The going in profit rates are based upon a system of "weighted guidelines" contained in ASPR 2-808. The guidelines provide, among other things, increased going in profits for increased contractor cost responsibility. ASPR states that "The first and basic determination of the degree of cost responsibility assumed by the contractor is related to the sharing of total risk of contract cost . . . through the selection of contract type." (36:365)

Table 6-1 contains the mean going in, adjusted, and coming out profit percentages for 834 FPI, CPIF, and CPFF contracts. The profit

TABLE 6-1

INITIAL, ADJUSTED, AND FINAL PROFIT PERCENTAGES
FOR 834 FPI, CPIF, AND CPFF CONTRACTS

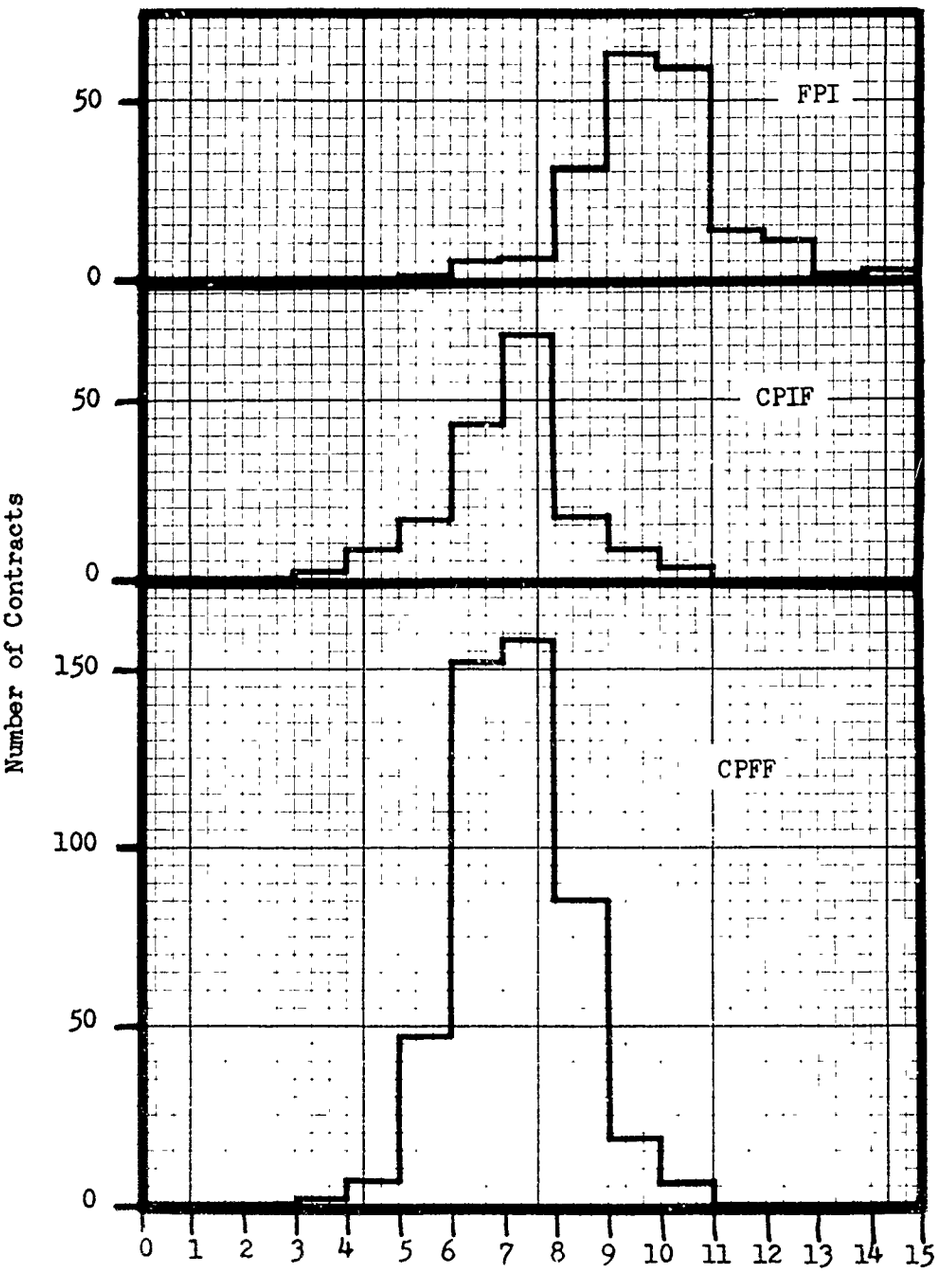
Contract Type	Number	Initial		Adjusted		Final	
		Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
FPI	195	9.69%	1.39%	9.59%	1.62%	9.10%	6.57%
CPIF	165	6.94	1.23	6.84	1.30	7.28	2.67
CPFF	474	7.17	1.09	7.08	1.19	7.03	1.35

rates for FPI contracts are consistently higher than the CPIF and CPFF rates. The mean FPI going in rate is 9.69% while the CPIF and CPFF rates are 6.69% and 7.17%, respectively. The standard deviations of going in profit appear to be very similar. Figure 6-1 contains histograms of the going in profits for each of the three types of contracts. This figure illustrates the going in profit differences between FPI and the CPIF and CPFF contracts.

The adjusted going in profit rate means shown in Table 6-1 are all slightly lower than the corresponding going in rate. This most probably reflects decreased uncertainties involved in the contract changes as compared to the original contracts. The standard deviations for adjusted going in profits are slightly larger than the corresponding measure for the initial profit targets.

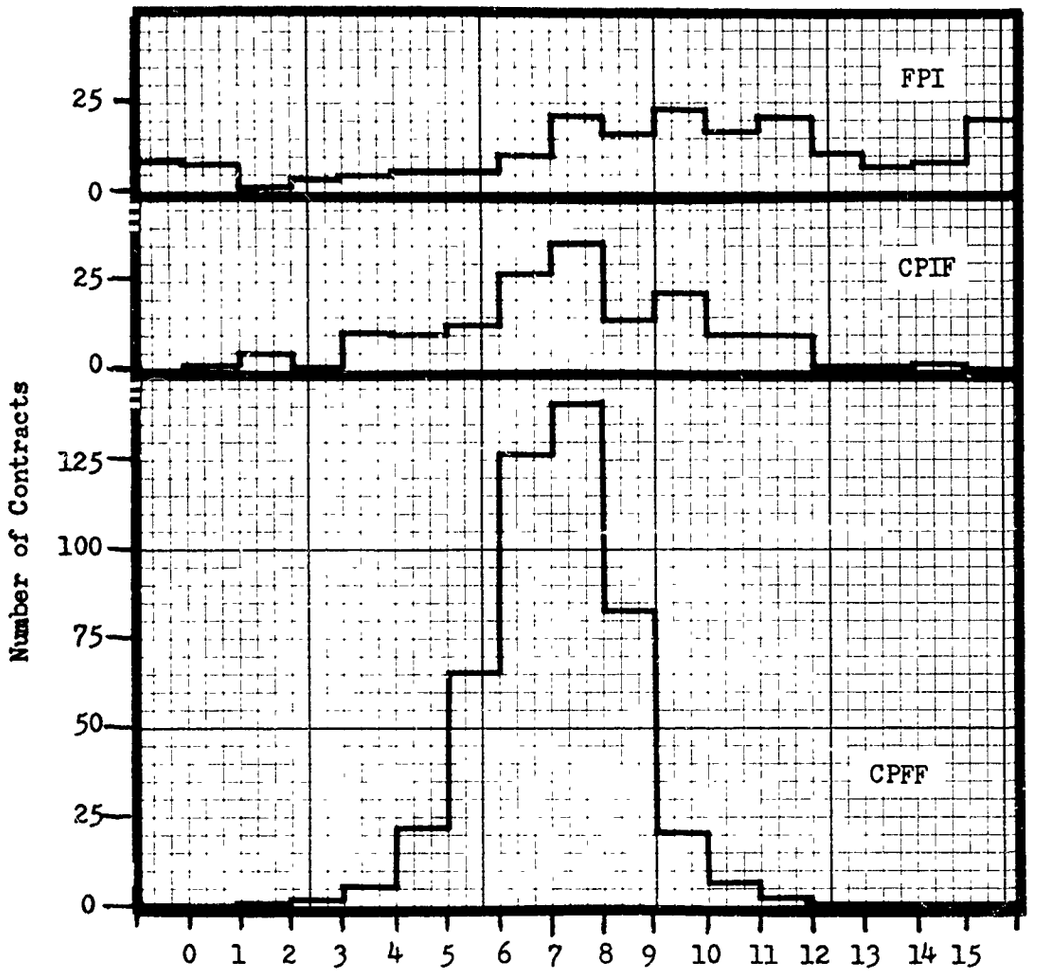
The mean coming out profit rates for FPI, CPIF, and CPFF contracts are 9.10%, 7.28%, and 7.03%, respectively. The standard deviations for the coming out rates evidence an increased dispersion for all types of contracts. The 6.57% standard deviation for actual FPI profit rates is four times as large as for the adjusted going in rates. Similarly, the 2.67% CPIF standard deviation is twice as large as the adjusted going in rate. Figure 6-2 contains histograms of the coming out profits for FPI, CPIF, and CPFF contracts. Figures 6-1 and 6-2 provide a very interesting contrast.

Once again, the important issue is the <u>significance</u> of the apparent differences in the going in and also in the coming out profit rates. The following section examines this question.



FPI	0	0	0	0	0	1	5	6	31	63	59	14	11	2	3
CPIF	0	0	0	2	8	16	43	68	17	8	3	0	0	0	0
CPFF	0	0	0	1	6	47	152	158	85	19	6	0	0	0	0

Fig. 6-1. Distribution of going in profits by type of contract.



FPI	9	8	2	4	5	6	6	10	22	16	23	17	21	11	7	8	20
CPIF	0	2	5	1	11	10	13	27	36	14	22	10	10	1	1	2	0
CPFF	0	0	1	2	5	22	65	126	141	83	20	7	2	0	0	0	0

Fig. 6-2. Distribution of coming out profits by type of contract.

Analysis of Variance of Going In and Coming Out Profits

To test the hypothesis of equality of profit means for FPI, CPIF, and CPFF contracts and for production and research contracts two-way analyses of variance were performed. These are summarized in Tables 6-2 and 6-3.

The first and second analyses of variance had similar results. The first was performed for going in profit for the three types of contracts and the two types of work. The second considered adjusted going in profits for the same factors. In both of these tests the null hypothesis for contract means was rejected at the 1% level of significance. Similarly, the tests found that the profit differences for the two types of work are not statistically significant at the 1% level. The inferences for going in profits are detailed in Tables 6-2b. In short, these two tests revealed that the negotiated target profits differ by contract type but not by type of work.

The outcomes for coming out profits are different. Both the null hypothesis for contract type and the null hypothesis for type of work are rejected at the 1% level. This is evidenced in Table 6-3b. Production contracts average coming out profit is 0.67% greater than the profit for research work. The mean coming out profit for FPI contracts is 9.26% while the corresponding figures for CPIF and CPFF contracts are 7.28% and 6.89%, respectively. These adjusted means are shown in Table 6-3c.

The preceding set of results is substantive. It shows that going in profits are significantly different for the different types of contracts as are the coming out profits. Even more revealing is that for coming out profits there is a significant difference between production

TABLE 6-2

ANALYSIS OF VARIANCE OF GOING IN PROFIT
AS A PERCENTAGE OF TARGET COST FOR
834 FPI, CPIF, AND CPFF CONTRACTS

6-2a. Number and Mean Profit Percentage

Type of Contract	Production		R&D	
	Number	Mean	Number	Mean
FPI	144	9.67%	51	9.74%
CPIF	84	6.75	81	7.14
CPFF	142	7.10	332	7.20

6.2b. Adjusted Analysis of Variance

Source of Variation	d.o.f.	Sums of Squares	Mean Square
Work	1	4.28	4.28
Contract	2	941.08	470.54**
Interaction	2	3.21	1.61
Within	828		1.42

** Null hypothesis rejected at the 1% level of significance.

6-2c. Adjustments

Adjusted difference in mean profit due to type of work: -0.15%

	FPI	CPIF	CPFF
Adjusted contract means:	9.65%	6.94%	7.20%

TABLE 6-3

ANALYSIS OF VARIANCE OF COMING OUT PROFIT
AS A PERCENTAGE OF ACTUAL COST FOR
834 FPI, CPIF, AND CPFF CONTRACTS

6-3a. Number and Mean Profit Percentage

Type of Contract	Production		R&D	
	Number	Mean	Number	Mean
FPI	144	9.58	51	7.73
CPIF	84	7.72	81	6.82
CPFF	142	7.11	332	6.99

6-3b. Adjusted Analysis of Variance

Source of Variation	d.o.f.	Sums of Squares	Mean Square
Work	1	80.48	80.48**
Contract	2	408.14	204.07**
Interaction	2	84.26	42.13
Within	828		12.39

** Null hypothesis rejected at the 1% level of significance.

6.3c. Adjustments

Adjusted difference in mean profit due to type of work: 0.67%

	FPI	CPIF	CPFF
Adjusted contract means:	9.26%	7.28%	6.89%

and research contracts while no meaningful difference exists between types of work for going in profits.

Profits for Incentive Contracts

The 264 incentive contracts considered in this section are the same as those used in the incentive contract analysis of the preceding chapter. The division into three groups based upon the size of the contractor's sharing percentage is also the same.

A two-way analysis of variance was performed for going in profit, adjusted going in profit, and coming out profit using three different α groups and two types of work as the factors. Details of the going in and coming out analyses are contained in Tables 6-4 and 6-5. Results of the three analyses may be simply summarized. The null hypotheses for size of the contractor's sharing percentage and for the type of work were rejected at the 1% level of significance for all three tests. The going in as well as coming out profit rates are higher for production than they are for research and development contracts. Also, the groups of contracts with a sharing percentage greater than 15% evidence a significantly higher going in and coming out profit rate than does the group with smaller sharing rates.

The interesting question is not whether or not the coming out profit rates differ between sharing ratios but rather whether there is a cause and effect relationship between these two variables. This section has included an analysis of the former question as background material. The latter question will be addressed in the next sections.

TABLE 6-4

ANALYSIS OF VARIANCE OF GOING IN PROFIT
AS A PERCENTAGE OF TARGET COST
FOR 264 INCENTIVE CONTRACTS

6.4a. Number and Mean Profit Percentage

Contractor's Sharing Percentage	Production		R&D	
	Number	Mean	Number	Mean
$\alpha \leq 15\%$	66	7.70%	40	7.50%
$15\% < \alpha \leq 30\%$	68	9.22	32	8.77
$30\% < \alpha$	45	9.36	13	9.77

6-4b. Adjusted Analysis of Variance

Source of Variation	d.o.f.	Sums of Squares	Mean Square
Work	1	10604.03	10604.03**
Share Ratio	2	11955.13	5977.57**
Interaction	2	5.06	2.53
Within	258		0.87

** Null hypothesis rejected at the 1% level of significance.

6-4c. Adjustments

Adjusted difference in mean profit due to type of work:			0.19%
	$\alpha \leq 15\%$	$15\% < \alpha \leq 30\%$	$30\% < \alpha$
Adjusted α group means:	7.65%	9.11%	9.50%

TABLE 6-5

ANALYSIS OF VARIANCE OF COMING OUT PROFIT
AS A PERCENTAGE OF FINAL COST FOR
264 INCENTIVE CONTRACTS

6-5a. Number and Mean Profit Percentage

Contractor's Sharing Percentage	Production		R&D	
	Number	Mean	Number	Mean
$\alpha \leq 15\%$	66	8.57%	40	6.79%
$15\% < \alpha \leq 30\%$	68	10.56	32	8.83
$30\% < \alpha$	45	10.53	13	7.26

6-5b. Adjusted Analysis of Variance

Source of Variation	d.o.f.	Sums of Squares	Mean Square
Work	1	12078.95	12078.95**
Share Ratio	2	13170.71	6585.36**
Interaction	2	19.01	9.50
Within	258		7.26

** Null hypothesis rejected at the 1% level of significance.

6-5c. Adjustments

Adjusted difference in mean profit due to type of work: 2.02%

	$\alpha \leq 15\%$	$15\% < \alpha \leq 30\%$	$30\% < \alpha$
Adjusted α group means:	8.15%	10.37%	10.35%

Regression of Profits, Sharing Rates, and Contract Growth

What is the relationship of the target profit, share ratio, and contract growth? Could it be that a large contractor sharing percentage coupled with a small target profit would strongly motivate efficient contract performance? Would the same large sharing rate in combination with a different target profit achieve the same result?

The significant differences found in the preceding section and Tables 5-10 and 5-11 suggest the use of regression analysis to determine the relationship of growth, profit, and sharing rates. The regression equations studied here are as follows:

(10) $\text{Change \%} = a + b(Pi) + c\alpha$, and

(11) $\text{Overrun \%} = a_1 + b_1(Pa) + c_1\alpha$,

where Pi = initial contract profit;

Pa = adjusted contract profit;

α = contractor's sharing percentage; and

a, b, c, a_1, b_1, and c_1 are undetermined coefficients.

Equation 10 relates percentage change, initial profit, and the contractor's sharing percentage. Eight different tests were performed using this equation to determine if a meaningful relationship does in fact exist. The results of these tests are listed in Table [illegible]. The 264 incentive contracts were examined first as a single group then by contract type, by size of the sharing rate, and by the type of work involved. In none of the subsamples examined is the estimated value of

TABLE 6-6

REGRESSION COEFFICIENTS FOR EIGHT TESTS WITH GOING IN PROFIT AND CONTRACTOR'S SHARE RATIO AS THE INDEPENDENT VARIABLES AND CHANGE PERCENTAGE AS THE DEPENDENT VARIABLE

Contract Group	a	b	Standard Error of b	Null Hypothesis Rejection Level for b	c	Standard Error of c	Null Hypothesis Rejection Level for c
264 FPI & CPIF	68.196	-0.057	0.061	0.36	0.917	0.927	0.33
179 Production	68.173	-0.061	0.085	0.48	1.314	1.309	0.33
85 R & D	65.780	-0.039	0.041	0.35	-0.380	0.609	> 0.50
159 FPI	1.012	-0.014	0.054	> 0.50	1.478	0.592	0.02
105 CPIF	-77.312	0.170	0.197	0.40	1.264	2.864	> 0.50
106 $\alpha \leq 15\%$	43.191	-0.006	0.037	> 0.50	-1.137	1.913	> 0.50
158 $\alpha > 15\%$	140.584	-0.111	0.104	0.30	0.283	1.688	> 0.50
58 $\alpha > 30\%$	-122.093	0.007	0.101	> 0.50	4.015	2.432	0.11

the coefficient of the going in profit, b, significant such that it could be concluded that change is determinable from the going in profit. Similarly, in none of the cases is the estimated value of c significant at the 1% level. As in Chapter V, the group of 159 FPI contracts has an estimated value of c significant at the 2% level. The meaning of this significance is not clear when the results of the other tests are considered. It must be concluded that the contract change as a percentage of the initial cost target is not a function of the going in profit or the contractor's incentive sharing rate.

Overrun/underrun, adjusted going in profit, and the contractor's sharing rate are related in Equation 11. Again, eight different tests were performed in order to determine if the adjusted going in profit and sharing rate have a meaningful relationship with the overrun/underrun outcome. Table 6-7 summarizes these eight tests. None of the estimated values of the coefficients b_1 and c_1 are significant at the 1% level. Thus, the contract overrun/underrun outcome is also independent of the going in profit and the contractor's incentive sharing rate.

Historical Profit Information

Information regarding DOD profit rates for years prior to 1960 is at best sketchy. The reason for this is that no continuous data collection system existed. Samples of contracts were assembled when required for special studies or congressional inquiries. The often quoted works of Moore (9) and Scherer (14) were based on groups of these samples which had been gathered for other purposes. In the early 1960's summary data was, at least for high value contract, collected by DOD. Even so, information about actual coming out profits was not typically

TABLE 6-7

REGRESSION COEFFICIENTS FOR EIGHT TESTS WITH ADJUSTED GOING IN PROFIT AND CONTRACTOR'S SHARE RATIO AS THE INDEPENDENT VARIABLES AND OVERRUN/UNDERRUN PERCENTAGE AS THE DEPENDENT VARIABLE

Contract Group	a_1	b_1	Standard Error of b_1	Null Hypothesis Rejection Level for b_1	c_1	Standard Error of c_1	Null Hypothesis Rejection Level for c_1
264 FPI & CPIF	2.706	-0.002	0.005	> 0.50	-0.023	0.085	> 0.50
179 Production	-7.457	0.005	0.005	0.32	0.040	0.078	> 0.50
85 R & D	16.884	-0.013	0.013	0.32	-0.015	0.212	> 0.50
159 FPI	2.464	-0.005	0.006	0.40	0.089	0.076	0.25
105 CPIF	0.763	0.007	0.016	> 0.50	-0.320	0.235	0.18
106 $\alpha \leq 15\%$	9.344	0.004	0.011	> 0.50	-1.046	0.589	0.08
158 $\alpha > 15\%$	-3.513	-0.002	0.005	> 0.50	0.157	0.094	0.10
58 $\alpha > 30\%$	-6.384	-0.007	0.009	0.44	0.345	0.231	0.30

made available to the public until the end of 1968. This release, Profit Rates on Negotiated Prime Contracts, by DOD provides detailed going in and coming out profit information for fiscal years 1959 through 1968. (40)

Table 6-8 summarizes going in and coming out profit information from the DOD release which is relative here. Note that the information is split into two time periods--before and after the end of calendar year 1963. It should also be noted that the profit figures are dollar weighted means and therefore a comparison with corresponding unweighted mean data in Table 6-1 should be accomplished with caution.

TABLE 6-8

GOING IN, ADJUSTED, AND COMING OUT PROFITS
FOR DOD CONTRACTS: 1959 - 1968

(Dollar Weighted Means)

Type of Contract	Going In		Adjusted Going In		Coming Out	
	Through CY 63	After CY 63	Through CY 63	After CY 63	Through CY 63	After CY 63
FPI	9.1%	9.7%	9.1%	9.5%	9.1%	8.5%
CPIF	6.7	6.9	6.5	6.8	7.7	7.3
CPFF	6.3	6.8	6.3	6.5	6.0	6.5

Source: U. S. Department of Defense, Directorate of Statistical Services, Profit Rates Negotiated on Selected Prime Contracts--Fiscal Year 1968, December 10, 1968, p. 12.

The information released by DOD provides a consistent basis upon which to evaluate what has happened to the various profit rates due to the incentive environment. For all types of contracts the going in profit rates have increased from the early to the later period. For example, the mean FPI going in rate has increased from 9.1% to 9.7%. The coming out rates have not followed suit for all types of contracts. The mean coming out rate for CPFF contracts has increased while the rates for incentive contracts have decreased. These results are certainly unexpected because they are inconsistent with the basic motivational theory of incentive contracting.

Conclusions

The following conclusions are primarily based upon the results of analyses of variance and regressions performed on actual contract outcome information:

1. Fixed-price and cost type contracts have significantly different going in profit rates. However, production and research contracts do not. This suggests a possible inconsistency in the matching of contract type and the work to be accomplished. It further suggests the possibility that greater attention may be paid to the form of the contract than the uncertainties of the subject work.

2. The coming out profit rates differ significantly between FPI, CPIF, and CPFF contracts. Production contracts earn a small but significant premium over research and development contracts. This is consistent with the finding that research and development contracts have a higher average overrun.

3. The going in profit rate does not significantly effect the percentage change in target cost or the overrun/underrun outcome. In a very broad sense this may be interpreted as a lack of sensitivity to a small incremental change in profit.

4. FPI, CPIF, and CPFF contracts awarded during the incentive environment years have higher mean going in rates than did similar contracts in previous years. However, the realized profits for incentive contracts have decreased while the actual profits for fixed-fee contracts increased.

CHAPTER VII

THE QUANTITATIVE RESULTS AND OTHER OBSERVATIONS

Despite the results of the empirical analysis, incentive contracts have a basic intuitive appeal. Are there other factors which have influenced the contract outcomes? This chapter contains a series of other factors included in the findings of previous DOD sponsored, NASA sponsored, and unsponsored research. Additional considerations are introduced. These are based upon a search of the literature, extensive interviews with industry and government procurement officials, and personal experiences.

Relationship of Industry Trends and Contract Outcomes

The results of the financial ratio analysis of the defense and space industry firms are consistent with the results of the examination of actual contract outcomes. The defense and space oriented firms have not experienced relative increases in return on sales, assets, or net worth, total or equity capital, and sales dollars per employee. The contract outcomes indicate that the percentage of cost overrun is not different for fixed and incentive fee contracts. The evidence shows that although the recent (1963-1968) incentive contracts have higher going in profits their coming out profits are lower.

Perhaps the apparent difference between the industrial profit rates and the contract profit rates needs clarification. The average coming out

profit for the sample of 834 contracts examined is 7.56%. This percentage is based upon before tax profits divided by allowable costs. It is equivalent to an after tax profit on allowable cost of approximately 3.78%. This percentage reduces even further when total costs are considered and when it is converted from return on costs to return on sales. Thus, the return on sales industrial data shown in Figure 4-2 are consistent with the coming out contract profits included in Table 5-1.

Factors Identified in Previous Research

Many other studies of incentive contracting have been completed. A review of the findings of six of these studies (14, 42, 61, 130, 141, 144) was included in the Logistics Management Institute's recent document, An Examination of the Foundations of Incentive Contracting. (76:11-14) These findings related to factors in addition to direct contract outcomes. The eleven findings "on which most of the six studies concur, and on which none takes exception" follow:

1. Extra-contractual considerations dominate over profit or fee. A contractor rarely seeks to maximize profit during the short run of a single contract. He is more interested in taking actions that will expand company operations, lead to increased future business, enhance company image and reputation, benefit his non-defense business, or relieve such immediate problems as loss of skilled personnel and a narrow base for fixed costs.

2. No significant correlation can be found to exist between cost sharing ratios and overruns or underruns.

3. Incentives have not been significantly effective as protection against cost growth on programs.

4. Contractors establish upper limits on profit on government contracts. Those limits pertain to individual contracts and to overall business with the Government. A large profit or fee on a contract arouses suspicions of cost padding and profiteering, making future negotiations more difficult and possibly damaging company reputation. . . .

Contractors go to great lengths to avoid investigation and to avoid refunds resulting from renegotiation.

5. Incentives are costly to negotiate and administer. The process of making a contract change is much more complex when an incentive arrangement is involved.

6. Contractors will not sacrifice performance attainment for profit. Performance is of such importance to company image and future business acquisition that all performance incentives provide little, if any, additional motivation to the contractor. [This is actually an extension of the first finding.]

7. It is often difficult to pass incentive motivation to the people who carry out the contract effort on a day-to-day basis, because it is difficult to relate individual activity with specific contracts. Many workers' time cannot be associated with specific contracts in such a way that they usually know what contract they are working on and what the incentive arrangement is.

8. Incentives do not work to the disadvantage of the Government except in administrative costs. When a contractor discovers that his incentive arrangement does not correspond to the Government's interest, he ignores the incentives.

9. Incentives serve as a planning discipline for DOD personnel. When an incentive arrangement is to be negotiated, requirements analysis is more thorough and the work statement is more precise.

10. Incentive structures clearly communicate the Government's objectives to the contractor. They attract special management attention to the objectives and explicitly show their relative importance.

11. When it is possible to associate activities of individuals with specific contracts, incentives provide a useful tool for motivating workers.

The LMI report qualifies finding 2 and 3. They "cannot be considered conclusive because they are based on contracts negotiated early in [and prior to] the DOD effort to increase the use of incentives. A learning period usually is essential for both government and contractor personnel before any substantial change in policy is successfully

implemented." Thus, the need for the analysis contained in Chapters IV through VI is further substantiated.

No information found during the literature search phase of this study is in opposition to the findings summarized by LMI except for the previously discussed beliefs on the profit maximizing objective. Further, unstructured interviews conducted with government and industry procurement officials revealed nothing which could be construed as being inconsistent with the eleven findings.

In addition to those summarized by LMI, other significant factors remain. They include intercontract dependencies, an incentive dilution effect, the tax effect, and the proper mating of type of contract and uncertainty. Each of these topics is discussed in this chapter.

Intercontract Dependencies

At any given point in time each defense and space contractor is working on more than one and usually a large number of contracts. These contracts typically are with several different government procuring agencies and have different periods of coverage. The set of contracts, for the large defense and space contractors, contains virtually every type of pricing arrangement available from the spectrum of authorized types.

Of course many priority oriented problems exist due to a multiplicity of contracts. This is certainly not a completely original thought but for some unknown reason it never receives attention. The 1965 NASA Incentive Contracting Guide discussed a portion of the problem: ". . . if for every dollar of cost incurred the contribution to fixed overhead is greater than the amount by which fee is reduced, it may be to the contractor's advantage to increase costs." (52:206) Backe, in Aviation Week

and Space Technology, showed how a profit maximizing contractor, with a certain mixture of CPIF and FFP contracts, could increase his overall profits by overrunning the CPIF work. (88:69-72) In his 1966 study for the Navy, Hill included in his conclusions a statement that the "assumption that the contractor behavior is independent of his contract mix is falacious." (141:3) In his "Incentive Contracts" chapter of Defense Management, Moore asserts that "A combination of contract-types obviously provides circumstances in a firm's operations that may make incentives less than fully operative." (3:29)

The question is, in a multi-contract firm, which contract (or portion of a contract) should receive the greatest management attention? Is it the contract which offers the greatest reward for cost reduction; i.e. the firm-fixed price contract? Should direct cost be scrutinized more carefully than indirect cost? If the firm is a profit maximizer, obtaining answers to these questions becomes computationally feasible.

The philosophy behind incentive contracting is that firms are profit maximizers. Thus a paradox exists. The profit maximizing assumption for each contract is in ASPR and other government publications while nothing about the possibility of intercontract tradeoffs is made available for government contracting officials. The most recent DOD/NASA incentive guide states that "the negotiator can only [emphasis added] be concerned with the instant contract." (48:18) It appears that the procurement policy's concept of industrial profit maximization may be actually suboptimal since it is not clear that maximization on each contract is the

policy that provides overall maximum profit. The basis of this situation is the accounting category of fixed costs.

Incentive Dilution

Are contractual incentives perceived as incentives by industry? Are they perceived as incentives by the government? Are they transformable into management actions? If the answers to these salient questions are negative the results of the empirical analysis are not surprising. No claim is made as to the independence of these questions.

Scherer discusses the first of these three questions. He states that "A government agency can profess that it will reward contractors who perform efficiently and penalize those who perfrom inefficiently, but if the contractors do not believe it, the agency's expectation will have created no incentive for efficiency." (14:6)

If the government contract administrators and program management officials at the working level do not consider the incentive provisions of a contract to be true motivators the value of automatic incentives will be diminished. This is due to the amount of control actually executed on large defense contractors by government program management and resident contract management personnel. The perception of motivation in the minds of officials at the policy level is less important.

It is relatively easy for an entrepreneur to transform a single business opportunity into management action. As the number of opportunities available increases, the set of actions necessary to transform opportunity into successful realization becomes complex. The transformation problems of a huge defense firm with its multiplicity of goals, contracts, incentives, organizational elements, etc. become immense. This problem is directly related to the LMI finding number 7.

In a complex environment the incentives from any single contract are diffused. What does an 80/20 sharing ratio mean to a contractor in relation to his other business? What does it mean in relation to other ratios such as 85/15, 70/30, and 60/40? Statements in the coordination draft of the DOD/NASA 1969 Incentive Contracting Guide allude to the problem of sharing rate differences:

1. ". . . it is inconceivable that there might be a variation in the effect between a 60/40 . . . and a 58/42 sharing rate. At the same time, it is easy to understand the effect of the difference between a 50/50 rate and a 65/35 rate; however, studies to date have not determined an exact correlation between overruns/underruns and the sharing rate." (48:147)

2. "Certainly, a 72/28 . . . can be traded-off for a 78/22 sharing rate in order to reach agreement on a target fee amount, and either arrangement can attract equal management attention." (48:206)

Evidentally, the government recognizes the lack of sensitivity to sharing rate differentials. A difference of two percentage points is not considered substantive: 42% - 40%. A difference of six percentage points is not considered substantive: 28% - 22%. For some reason the difference between 50% and 35% is "easy to understand". These comments are directed to the effects of various sharing ratios in one contract. When this cost sharing sensitivity problem is compounded with incentives on performance and schedule the perception of the subtle differences in sets of outcomes must become obfuscated.

Now consider the contractor who has several fixed price, several incentive fee, and several fixed fee contracts on his books. What is his reaction to an additional contract having, say, a proposed cost sharing of 75/25? Is it probable that the 25% sharing potential of the additional

contract will attract his attention? Would he react differently if the sharing on the new contract were changed to 60/40? 100/0? The results of the empirical analysis indicate that the contractor's degree of cost responsibility does not change correlative to a change in the sharing rate.

Tax Effect

Income taxes paid by industry typically amount to approximately fifty percent of gross earnings. This basic fact in effect cuts in half the contractor's portion of an incentive sharing ratio. This simple effect causes a difference in the customer and contractor perceptions of the incentive. The customer perceives his actual reward as being twice as large as the reward is perceived by the recipient. This is due to the flow of dollars from a procuring agency to a contractor followed by tax dollars flowing from the contractor to the Internal Revenue Service and other tax collecting organizations. The procuring agency actually does pay, in profits, twice as much as the contractor is allowed to keep.

For example, with an 80/20 share ratio, a $100,000 cost reduction results in the government procuring agency paying a $20,000 bonus to the contractor. The contractor, other things being equal, receives the $20,000 bonus and pays an additional $10,000 in taxes. He constructively operates with a 90/10 rather than an 80/20 sharing arrangement.

The tax effect could be attributed to every profit dollar a firm receives but it is a special case in government procurement since the buying agency and tax collecting agency are both elements of the same organization.

Mating of Contract Type and Uncertainty

A recent Aerospace Industries Association report on the "Essential

Technical Steps and Related Uncertainties in DOD Weapon Systems Development" states that ". . . the existing contractual policies and regulations are not compatible with the inherent technical uncertainty in the weapon system development process . . ." (128:22) A vice president of one of the largest aerospace firms reenforces the AIA conclusions:

> This gap between the form of the development contract and the substance of development work is the most serious flaw in today's operating procurement system. . . . Our ability to make accurate quantitative judgments as to the cost of monumental engineering projects has quite obviously not kept pace with either our ability to do the job or our facility at constructing complex contract forms. On either side of the equation we seem to do well; we send men around the moon and we devise multi-dimensional, inter-related incentive clauses. We do not, however, match the contract form to the job. (131:4)

Industry is not alone in concluding that the selection of the type of contract has not always been accomplished with sufficient consideration of the risks involved. Fisher's recent RAND report states that ". . . incentive contracts have been applied in numerous cases in which the technical uncertainties were so large that they precluded any meaningful target cost determination." (68:46)

The results of the empirical analysis are consistent with these concerns. It was found that the contracts with the greatest degree of uncertainty, research and development, actually experienced a significantly greater average percentage cost overrun than did the production contracts. Although both research and development and production contracts had similar going in profits, production contracts had significantly higher coming out profits.

What has caused the increased concern about matching the contract type with the applicable risks" The declining profits on research and development are really only symptoms.

It is possible that industry and government have both contributed to the problem. The defense and space industry interfirm rivalry for contracts strongly influences each individual firm toward accepting whatever type of contract the government desires to use. The fact that higher cost risk contracts have significantly higher coming out profits certainly does not mitigate aga t the influence of rivalry.

The government's possible contribution to the problem can be traced back to the beginning of the incentive environment. Contracting experience from the preceding years of intense missile and space capability build-up convinced top level government procurement officials that policy changes were in order. The newly adopted resource allocation procedures demanded tighter cost control. As previously discussed, the result was an increased emphasis on "cost responsibility". The DOD established goals to reduce the use of fixed-fee contracting were dramatically met as shown in Table 1-1. Even today, subordinate procuring organizations are closely monitoring the percentage of fixed-fee contracts awarded. The selection of the proper contract type has thus been influenced by a type of quota system. If the individuals involved in the selection of the type of contract to use for a specific procurement are unduly influenced by a quota system a resulting mismatch should not be surprising.

A Caveat

As with all empirical investigations, caution must be exercised in interpreting the results of the contract outcomes analysis. First of all it must be recalled that the sample of contracts was constrained by time, dollar value, and government procuring agency. Therefore, the results are based on the outcomes of large DOD contracts in the incentive

environment years. Known influential characteristics of the incentive environment have been discussed; however, others, at present unknown, certainly may exist.

What would the cost outcome have been if a fixed-fee contract had been used in lieu of an incentive fee? An incentive fee in lieu of a fixed-fee? A 60/40 sharing in lieu of 80/20? The answers to these questions will never be known. Also, it must be noted that, except for the contracts containing performance incentives, nothing has been said regarding the quality of the products procured. Throughout this research it has been assumed that the quality level is independent of the type of contract.

Contracts were not randomly selected for each individual procurement. A variety of considerations influenced the selection of the contract elements including type of pricing arrangement and size of the contractor's sharing percentage. If the considerations were improperly applied the contract outcomes could definitely be prejudiced. Similarly, if the considerations, themselves, contained some invalidity the outcomes could provide improper inferences. The empirical analysis reflects aggregate outputs from the environment. A great deal of judgment is required to relate characteristics of the environment to specific outputs.

CHAPTER VIII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The Department of Defense and the National Aeronautics and Space Administration have altered the policy for procuring a significant portion of the goods and services required by the world's largest consumer, the United States government. This change involved an attempt to motivate the producers to more efficient performance. The vehicle of this change was the emphasized use of contracts containing provisions for automatic cost and profit sharing. The primary purpose of this study is to examine the results of this change.

The study embraces the results for a period, defined as the incentive environment, beginning in fiscal year 1963. Three specific management actions set the stage for this environment. The administrative ceiling on profits for certain types of contracts was eliminated, the Armed Services Procurement Regulation was rewritten to emphasize preference for fixed-price and incentive contracts, and the Cost Reduction Program was formulated including an emphasis on fixed-price and incentive contracts as a salient element. The shift away from fixed-fee contracting was dramatic. In fiscal year 1962, fixed-fee contracts represented 32.5% of all DOD contracts. This figure dropped to 9.4% by fiscal 1965 and has remained fairly stable ever since.

Profit is placed in the perspective of the current concept of organizational objectives and in the context of the government procurement environment. Various factors limiting the range of available profits are discussed. Contractors face a host of upper and lower limits on their profits. Some of these limits are explicitly included in government contracts while others reflect pressures from extra-contractual sources. The government is similarly limited by contractual and extra-contractual constraints on the amount of profit with which it may reward industry. These viewpoints provide a framework on which the analysis of actual contract outcomes can be based.

The results of the attempt to motivate more efficient performance are viewed from two different perspectives. First, the effects of the incentive environment are examined in a macroscopic sense; i.e., have the defense and space industry firms evidenced increased efficiency through more effective use of their capital and labor resources? Second, a microscopic perspective is assumed by analyzing the outcomes of a large sample of recently completed incentive and fixed-fee contracts.

Due to the concentration of defense sales it is possible to examine, in detail, the profitability of a selected group of contractors and conclude, in a broad sense, the results of the switch to a much larger percentage of incentive and fixed-price contracts. For this examination the Fortune 500 firms are grouped on the basis of the percentage of their total sales represented by their combined DOD and NASA sales rather than the traditional classifications by industrial product line. Various financial ratios are calculated for each group for each year during the 1956-1967 period. The ratios are return on sales, assets, and net worth;

total capital and equity capital turnover; and sales dollars per employee. It is hypothesized that if the incentive contracting environment motivates defense and space contractors toward increased efficiency in the use of their capital and labor resources, the group of firms receiving over 50% of their sales from DOD and NASA would exhibit a relative increase in the various financial indicators.

The microscopic analysis of the results of the incentive environment is based upon a large sample of completed DOD contracts. These 834 contracts, all priced at over $200 thousand, were awarded not earlier than fiscal year 1963 and completed not later than fiscal year 1968. A series of questions are investigated to provide insight into contract growth (contract change and overrun/underrun) and profit. The relationships investigated include: (1) contract change and overruns/underruns, (2) contract growth and contract type, (3) contract growth and sharing ratio size, (4) contract growth and type of work, (5) profit and contract type, (6) profit and share ratio size, (7) profit and type of work, (8) cost and other contractual incentives.

In addition, this research considers a group of other factors which can influence the effectiveness of incentive contracts. A large number of these factors were found in previous research during the literature search phase. A few of them, such as communication of the government's objectives to the contractor and a more thorough requirements analysis, are beneficial. Others, such as the domination of extra-contractual considerations and increased cost of negotiation and administration, detract from the benefits of incentives. Four additional factors are postulated and discussed in this research: (1) intercontract dependencies,

(2) incentive dilution, (3) tax effect, (4) mating of contract type and uncertainty.

Conclusions

Defense procurement outcomes in the incentive contracting environment have not reflected well on the use of incentive contracts. This, of course, does not necessarily mean that selectively applied, properly structured, and appropriately controlled incentive contracts would not be effective. It does mean that the firms and contracts included in this analysis did not evidence the results associated with the "cost responsibility" theory of incentives. This position is based upon the following findings:

1. Firms receiving over 50% of their sales revenues from DOD and NASA have not evidenced increases in the selected management indicators relative to other large firms during the years of incentive emphasis. The indicators suggest that the group of large defense and space firms has, at best, maintained its relative position with other large industrial firms.

2. Target cost change (increase in target cost due to authorized additions to the contract) and cost overrun/underrun (actual cost less adjusted target cost) provide an interesting pair of outcomes. Change, as a percentage of target cost, differed significantly between types of contracts while cost overrun/underrun outcomes differed significantly between types of work. This suggests the possibility of a mismatching of contract type and type of work. The lack of difference in overrun/underrun outcomes for the different types of contracts shows the lack of a motivating effect in incentive contracts.

3. No conclusive relationship between the percentage change in target cost and the size of the contractors sharing ratio was found. In most of the tests performed, no significant relationship was determined. However, for a group of fixed-price incentive contracts a statistically significant relationship did exist; an increase in the sharing percentage corresponded with an increase in the percentage change in target cost.

4. Contracts with contractor sharing percentages greater than 15% evidenced a small average underrun while contracts with smaller shares evidenced a small average overrun. Except for this very gross relationship no significant relationship was found between the size of the sharing ratio and the overrun/underrun outcome.

5. A strong tendency exists for performance incentives to be at least partially earned. This tendency is independent of the overrun/underrun outcome. Conversely, schedule incentive tends to be at least partially lost. The lost schedule incentives correspond with cost overruns. The schedule incentive--cost incentive findings are weak due to the extremely small sample of these contracts included in the sample.

6. A comparison of information from this research and the results of earlier studies shows that recent FPI contracts have a higher average change than before while CPIF and CPFF contracts exhibit a lower average change percentage. Also, recent FPI contracts evidence an average overrun while earlier FPI contracts had an average underrun.

7. Greater attention may have been focused on the selection of the type of contract pricing provision itself than on the matching of the type of contract and the type of work. This is evidenced by the fact that fixed-price and cost type contracts have significantly different target

(going in) profit rates while production and research and development do not. Earned (coming out) profit rates differ significantly between FPI, CPIF, and CPFF contracts and also between production and research contracts.

8. A lack of sensitivity to small differentials in profit potential has been shown. The going in profit rate does not significantly effect the percentage change in target cost of the overrun/underrun outcome.

9. FPI, CPIF, and CPFF contracts awarded during the incentive environment period have higher going in profit rates than did similar contracts in previous years. However, the realized profits for incentive contracts have decreased while the realized profits for fixed-fee contracts increased.

Recommendations

1. The continued use of incentive contracting must be accompanied by a change in emphasis and a reexamination of the criteria for pricing arrangement selection. The decision as to the type of contract to use for a given procurement must be more selective than it has been. The uncertainties involved must be considered and reflected in the pricing arrangement to avoid mismatches. The resulting decrease in the number of incentives should reduce the dilution effect. The use of any type of quota system for selecting the pricing arrangement to be used must be discontinued.

2. The emphasis on the use of multiple incentive contracts may be reduced. The mathematical theory of incentive tradeoffs is not in question. The lack of evidence regarding the transformation of that theory into management action supports the decreased emphasis as does the evidence regarding the achievement of performance and schedule incentives. This reduced emphasis will also decrease the dilution effect and take advantage of extra-contractual motivators.

3. Consideration must be given toward the effects of inter-contract dependencies. Government program management and contract administration personnel should be provided with the necessary guidance as to how these dependencies should be considered in the structuring, negotiation, and administration of contracts.

4. Some minimum contractor sharing arrangement, say 30%, should be established for incentive contracts. This would eliminate the use of very shallow share ratios and force incentive contracts into a form substantively different than fixed-fee. If this recommendation were to be adopted, a follow-up analysis should be performed to determine if the actual contract outcomes evidence any meaningful relationship to the limited incentives.

5. Some data base should be established for profit achievement, and hence cost performance, for firm-fixed-price contracts. Without this information it is impossible to validate the theory that fixed-price contracts provide the customer with the best possible price. This information would provide further knowledge of the workings of the profit motives of the defense and space industry.

6. Research should be undertaken to determine the outcomes of the incentive environment for small firms. The findings in the current study are primarily based on large contracts and large contractors. Perhaps the empirical results are not applicable to small firms. It is quite possible that the motivations of giant corporations are substantively different than the motivations of smaller organizations dealing with the government. Properly structured procurement policy must provide for these differences if indeed they do exist.

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The DOD and NASA are continually searching for ways to improve the procurement process. The fact that a massive attempt was undertaken to motivate increased contractor efficiency through contractual incentives is consistent with this desire for improvement and should be applauded. However, the outcomes of this undertaking must be analyzed in order for the experiment to provide meaningful information for future action.

Accordingly, the spirit and intent of this research has certainly not been to criticize by finding fault. Those thousands of individuals responsible for developing, implementing, and executing government procurement policy are faced with the seemingly impossible task of obtaining, in an efficient manner, the myriad of highly complex systems and equipment deemed, by others, to be necessary. Their problem is compounded by limitation in cost estimating capability by both the customer and the contractor, anticipated inclusion of as yet unknown technology, and possible procuring agency and contractor benefits from using an optimistic estimate strategy. The real intent of this research has been to contribute to the foundations upon which procurement policy will continue to improve. The basis and direction are perhaps best summarized by Lee:

> DOD has not solved the basic problem of the correct contract types to use in purchasing major weapons. In fact, this is a problem which can never be fully solved. Solution of the problem is impossible because the basic responsibility of the nation's largest buyer is to <u>defend</u> well--to buy well must come second. . . . The fact that the problem of contract types cannot be fully solved should not prevent DOD from working toward the goal of an improved situation. (8:570-571)

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13 ABSTRACT

The primary purpose of this research is to examine the results of the dramatic shift by the Department of Defense and the National Aeronautics and Space Administration in the use of contracts containing automatic cost and profit sharing incentives. The use of capital and labor resources, over time, are compared for defense and other large firms. The outcomes of a large sample of recently completed incentive and fixed-fee contracts are analyzed. Extra-contractual factors are postulated and discussed.

Defense procurement outcomes have not reflected well on the use of incentive contracts. The firms and contracts included in this analysis did not evidence the results associated with the theory of profit incentives. Specific findings and recommendations for improvement are included.

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